TECHNICAL NOTE NO. LWL-CR-02F71B

REPORT OF TEST ON ENGINEERING DESIGN AND SAFETY EVALUATION OF 40mm FLOATING FLARE

Final Report
Work Assignments No. 2 and No. 10
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The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

TABLE OF CONTENTS

I. GENERAL DATA

A. Purpose of Tests

The purpose of this program was to test the performance of the 40mm Floating Flare under various adverse conditions to evaluate the engineering design and to assure safety in handling and use.

B. Description of Test Samples

The 40mm Floating Flare can be launched from the M79 or the M203 40mm Grenade Launcher and is capable of flotation in swampy or water-covered, ground-level target areas. The flare provides troops in the field with standoff capability for marking a target or position in inundated areas during the hours of darkness. The flare was fabricated in three colors; green, red and yellow.

The assembled munition, shown in Figure 1 is 5.23 inches long, 1.60 inches in diameter and weighs 9.9 ounces. The projectile, consisting of a housing with delay train and the ballute/flare assembly, weighs 8.2 ounces and is 4.36 inches long. The cartridge case is the standard M195 cartridge case used on 40mm smoke marker ammunition and is olive drab in color. Figure 2 shows the projectile and the M195 cartridge case. The projectile housing is an aluminum cylinder, coated pale green in color and marked with the words "CARTRIDGE,40MM FLOATING FLARE" followed by the flare color "GREEN, RED or YELLOW." The nose is a plastic ogive, gray in color and is snapped into the forward end of the aluminum body. The ballute/flare assembly shown in Figures 3 and 4 consists of an aluminum shell,

40MM FLOATING FLARE CARTRIDGE

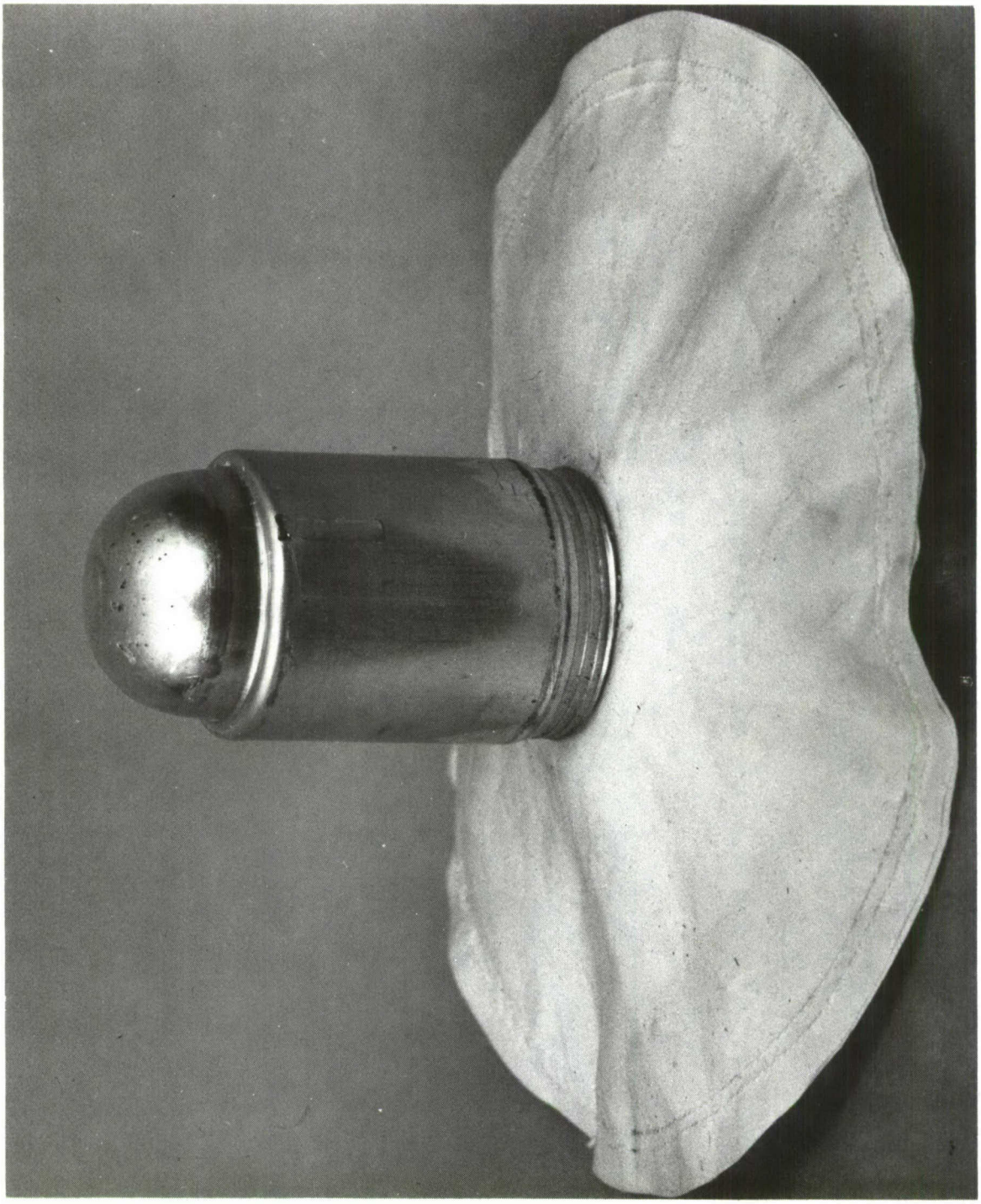
FIGURE 1

40MM FLOATING FLARE PROJECTILE AND CARTRIDGE CASE

FIGURE 2

BALLUTE/FLARE ASSEMBLY, SIDE VIEW

FIGURE 3



BALLUTE/FLARE ASSEMBLY, BOTTOM VIEW

FIGURE 4

uncoated, containing the flare mix and a flat, round ballute attached at the aft portion of the aluminum shell. The shell is 1.40 inches in diameter and 3.40 inches long. The ballute is a rubberized fabric, white in color, and fabricated of two pieces stitched around the perimeter and joined to the aluminum shell at the center. The ballute is 6 inches in diameter when unfolded.

In operation, the main charge in the cartridge case propels the projectile out the barrel and ignites the delay train in the projectile. With the projectile in flight, the delay burns for 5 to 6 seconds at which time a small charge ignites and ejects the ballute/flare assembly from the aluminum housing. This occurs between the apex and 1/3 descended in its trajectory. At ejection, the flare is ignited and the ballute is inflated by the gases generated by the flare. The burning flare then falls into the water and floats as the flare continues to burn for about 1-1/2 minutes.

For shipping, 22 rounds are packaged in the M2A1 Ammunition Box with each round in a fiberboard tube.

C. Disposition of Samples

Of the 250 40mm Floating Flare Cartridges (84 green, 83 red, and 83 yellow) furnished for testing, 187 rounds (63 green, 62 red, and 62 yellow) have been exposed to the required environmental conditioning and test fired for performance evaluation. The remaining 63 rounds (21 of each color) have been marked for identification, conditioning as required, and returned to USALWL for future recoil impulse measurement tests.

Also returned to USALWL were the M195 cartridge cases expended in test firing and all ballute/flare assemblies that were recovered after test firing.

II. ABSTRACT

This report describes the environmental testing and the subsequent operational performance of the 40mm Floating Flare. Environmental testing included sequential rough handling, high humidity, waterproofness, vibration, forty-foot drop, and high and low temperature storage. Performance testing involved the evaluation of delay times, burn times, range, flight characteristics, flotation characteristics, and the altitude at functioning.

It is concluded with reservation that the 40mm Floating Flare is safe for handling and use. The rough handling caused the nose caps to come off and they had to be replaced before continuing the testing. It was not determined whether a hazard exists if a cartridge is inadvertently fired without the nose cap in place. The cartridges in the forty-foot drop did not explode and were safe to handle afterwards. During testing there were no misfires at launching and all launchings were normal, presenting no hazard in that respect. A fire hazard does exist when the flare does not land in water. The extreme heat of the burning flare easily ignites grasses or brush.

During performance testing, three major types of malfunctions occurred, anyone of which prevented the complete operation of the flare. They are: (1) failure to function in flight, (2) failure to eject the flare after functioning, (3) failure to remain afloat after normal ejection and impact in water. With a total of 187 cartridges fired, these three types of failures combined to produce an overall failure rate of about 30%

including the control group. Excluding the control group, the failure rate was 32% and the failure rate for the control group alone was about 17% indicating a definite effect on the munition from the environmental conditioning.

The most serious failure rate occurred with the high humidity group (67%) which had 4 "no functions or ejections" and 4 flotation failures. Temperature conditioning appeared to be a very significant factor in effecting performance. Of the 12 cartridges fired at 160°F, 7 either did not function or did not eject after functioning. Of the 12 cartridges fired at -70°F, 6 failed to eject after functioning and 2 sank. The failure rates for 125°F and -45°F were not as high indicating a correlation between failure rate and temperature extreme.

Of the 70% that operated normally, the flare color and brightness were generally good. Those flares that floated on the side usually had poor color. The 5.5 second average delay prior to functioning provided ejection at a point 1/8 to 1/3 descended in the trajectory in normal operation. After opening, the flare decelerated and fell straight down under no wind conditions. Because of the high functioning altitude and long descent after functioning, the wind greatly influenced both range and accuracy of the munition.

The flotation failures were caused by either of two types of malfunction. In some cases the ballute did not inflate properly in flight and the flare sank upon impact in water and burned submerged or surfaced after considerable under water burn. In other cases, the ballute was

damaged either with holes from burning slag from the flare or the seam at the ballute perimeter opened.

Recommendations

It is recommended that the operation of the 40mm Floating Flare be made more reliable in the areas of functioning and flotation as high failure rates were experienced in these areas. Also, the integrity of the nose cap connection should be improved as evidenced by the nose cap separations at the seven-foot drop and the loose cargo test.

The 5.5 second average delay causes functioning at a high altitude and the falling ballute is influenced by wind effecting both range and accuracy. It may be desirable to increase the delay time to 6.0 or 6.5 seconds to provide for a lower functioning altitude with the resulting decreased exposure time to wind. The longer delay would improve accuracy and would also serve to increase the range.

III. REFERENCES

U. S. Army Test and Evaluation Command
Aberdeen Proving Ground
Materiel Test Procedures:

MTP 4-2-601

MTP 4-2-602

MTP 4-2-804

MTP 4-2-820

IV. FACTUAL DATA

A. Test Apparatus and Equipment

1. M79 Grenade Launcher, 40mm, Serial No. 7943
2. Adjustable Elevation Table
3. Mount, M79 Grenade Launcher
4. Gunner's Elevation Quadrant
5. Environmental Conditioning Apparatus (See Appendix I)

B. Environmental Test Procedures (See Appendix I)

C. Performance Measurement Set-Up and Procedure

The pond at the Hartwood, Virginia site of General Environments Corporation was used as the target area for testing the 40mm Floating Flares. The pond irregularly shaped, measured approximately 60 meters long and 30 meters wide. White nylon lines were placed across the pond at 10 meter intervals to visually establish range at impact. The launcher location was originally established at a point 240 meters from the front of the pond. During testing, however, wind conditions necessitated the establishment of a second firing position 25 meters closer to the pond. Therefore, during testing, all rounds were fired from a distance of either 240 meters or 215 meters from the pond depending upon the wind conditions. Figure 5 is a illustration of the pond showing the marker line locations.

The M79 launcher was fired from a mount clamped to an adjustable elevation table which was weighted to prevent movement during firing. The elevation for all firings was set at 45^{o} and checked with a gunner's quadrant prior to firing each environmental group and with each relocation of the firing site.

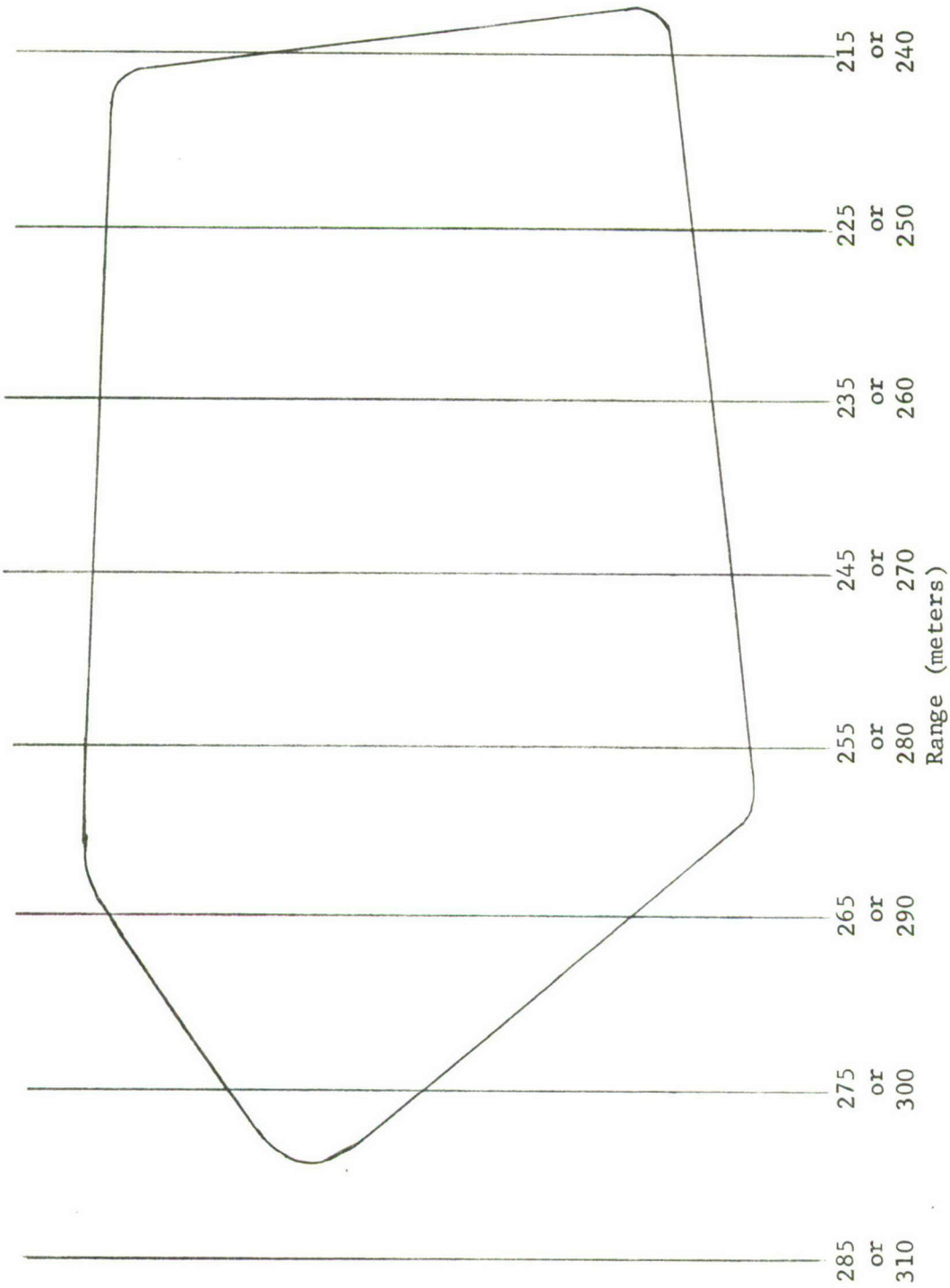


Figure 5. Target Pond

All test firing was conducted by AAI personnel. There was one man at the launcher site and two observers at the pond to record delay time and burn time and to observe the general operation of the flares. Communication was established between the gunner and the observers with hand-held transceivers.

Delay time was measured using a stop-watch held by one of the downrange observers. At firing, the gunner's tranceiver was left open so the observers could hear his countdown. At the instant the firing lanyard was pulled, the gunner signaled "fire" at which time the stop-watch was started. The watch was stopped at the sound of functioning or ejection. Since the observers were approximately 70 to 80 meters away from the projectile in flight at ejection, there would be about a 1/4 second error in timing the event based on the sound. To compensate for this 1/4 second delay, the start of the watch was delayed by a small amount after the signal of "fire" from the gunner was received.

The burn time was measured by the second observer using a stop-watch and he also observed flotation characteristics using binoculars. Only the visible signal time is reported. For those that sank, continued burn underwater is not reported as burn time.

All test firing was coordinated with the requirements of the environmental testing. Performance data was recorded for the firing of one hundred-eighty-seven (187) flare cartridges (63 green, 62 red and 62 yellow). The cartridges to be fired were selected from those that had undergone various treatments as follows:

- one of each color from each M2A1 box from the seven-foot packaged drop test (4x3)
- one of each color from each M2A1 box from the loose cargo test (4x3)
- seven from each M2A1 box from the five-foot drop test (4x7)
- five of each color from the high humidity test (5x3)
- four of each color from the waterproofness test (4x3)
- four of each color from the vibration test (4x3)
- six of each color from the forty-foot drop test (6x3)
- eight of each color from the high temperature storage test (8x3)
- eight of each color from the low temperature storage test (8x3)
- ten control rounds of each color (10x3)

All rounds were fired at ambient temperatures (45^{o} to 60^{o} F) except those in high and low temperature storage tests; those were fired as soon as possible after removal from the conditioning chamber. They were removed three at a time and carried to the launch site in an insulated container.

Since the wind greatly effected accuracy and range, it was necessary to use control rounds occasionally to readjust the aim as weather conditions changed. As a result, 8 control rounds missed the pond while appearing to have functioned normally so that flotation characteristics could not be evaluated for those rounds.

D. Results of Performance Tests

After the seven-foot drop of the rough handling sequence, it was found that the nose caps of all 88 cartridges had been loosened or had completely separated from the cartridge housing. All were replaced prior to continuing testing. The nose caps were again loosened or separated during the loose cargo sequence of rough handling and were again replaced prior to continuing. A few of the cartridges experienced small dents at the forward rim of cartridge housing near the nose cap during the five-foot individual drop test. These were the only visible damages resulting from the environmental conditioning.

The cartridges in the forty-foot drop did not explode and were safe to handle afterwards. These cartridges were later test fired at the request of the government Project Officer.

Table I contains a summation of the test data including averages of times and ranges for the environmental groups. The delay times averaged include those cartridges which functioned audibly even though ballute ejection did not occur. This occurred in 17 tests. Burn time averages do not include those flares which burned part of the time or completely underwater but only those which floated normally and those which impacted on hand. The land and water burn time averages are listed separately. Range averages do not include those flares which did not function or eject but only those which functioned and ejected normally. In the floatation data, those listed as "sank" include those that submerged for a significant portion of the burn as well as those which sank completely and burned underwater.

TABLE I. AVERAGES OF RESULTS FOR ENVIRONMENTAL GROUPS

NO. FIRED	CONDITIONING	DELAY TIME (NO.)	BURN TIME (NO.)	RANGE (NO.)	FLOTATION	FUNCTION BUT NO EJECTION	NO FUNCTION
30	Control	5.5 sec (29)	87 sec (18) water 74.4 sec (8) land	262M (28)	2 sank 2 on side of (20)	2	0
6	7 Ft Drop; -50°F	5.7 sec (6)	85 sec (5) water	242M (6)	1 sank of (6)	0	0
6	7 Ft Drop; 145°F	5.4 sec (6)	86 sec (5) water	246M (6)	1 sank 1 on side of (6)	0	0
6	7 Ft Drop; loose cargo; -50°F	5.2 sec (6)	85 sec (5) water 78 sec (1) land	246M (6)	5 ok of (5)	0	0
6	7 Ft Drop, loose cargo; 145°F	5.3 sec (6)	87 sec (4) water 83 sec (2) land	240M (6)	4 ok of (4)	0	0
14	7 Ft Drop; loose cargo, 5 Ft drop; -50°F	5.4 sec (12)	85 sec (10) water	248M (12)	2 sank of (12)	0	2
14	7 Ft Drop; loose cargo; 5 Ft Drop; 145°F	5.3 sec (13)	86 sec (8) water 79 sec (4) land	250M (13)	1 sank 1 on side of (9)	0	1
15	High Humidity	5.7 sec (13)	80 sec (6) water 92 sec (1) land	260M (11)	4 sank of (10)	2	2
6	Waterproofness, 4 Hr.	5.2 sec (6)	86 sec (4) water	265M (5)	1 sank of (5)	1	0

NO. FIRED	CONDITIONING	DELAY TIME (NO.)	BURN TIME (NO.)	RANGE (NO.)	FLOTA-TION	FUNCTION BUT NO EJECTION	NO FUNCTION
6	Waterproof-ness; 48 Hr.	5.3 sec (6)	95 sec (3) water 79 sec (1) land	256M (6)	1 sank of (5)	0	0
6	Vibration; -50°F	5.2 sec (6)	83 sec (4) water	253M (5)	1 sank of (5)	1	0
6	Vibration; 145°F	5.1 sec (5)	83 sec (5) water	241M (5)	5 ok of (5)	0	1
18	40 Ft. Drop	5.4 sec (18)	86 sec (12) water 83 sec (5) land	262M (17)	2 on side of (12)	1	0
12	High Temp. 125°F	5.5 sec (11)	80 sec (8) water 66 sec (1) land	278M (11)	2 sank 1 on side of (10)	0	1
12	High Temp. 160°F	5.5 sec (8)	75 sec (5) land	220M (5)	None - in Water	3	4
12	Low Temp. -70°F	5.9 sec (12)	88 sec (4) water 78 sec (1) land	267M (6)	1 sank of (6)	6	0
12	Low Temp. -45°F	5.7 sec (12)	89 sec (9) water 78 sec (1) land	261M (11)	1 sank of (10)	1	0
Total 187	All	5.47 (175)	86 sec (110) water 78 sec (30) land	256M (159)	19 sank 7 on side of (130)	17	11

Of the 187 test firings conducted with the 40mm Floating Flare, 11 flares failed to function and 17 functioned but failed to eject the ballute/flare assembly. Combined, these 28 failures produced a function/ejection failure rate of 15.0%. The highest percentage of this type of malfunction occurred during high and low temperature testing. The firings at 160°F yield 4 "no functions" and 3 "no ejections" of the 12 for a function/ejection failure rate of 58%. Firings at -70°F produced 6 "no ejections" of the 12 tested for a failure rate of 50%.

Of the 130 flares tested which impacted in water, 19 sank completely or for a significant portion of the burn and 7 floated on the side producing poor color. The 19 that sank are considered flotation failures and yield a failure rate of 14.6%.

By combining the three major types of failures which are (1) no function, (2) function but no ejection, and (3) those that sank, an overall failure rate of 29.6% was experienced during performance testing for all those tested including control rounds. The individual failure rate for each environmental group is listed below in Table II.

TABLE II. FAILURE RATES FOR ENVIRONMENTAL GROUPS

CONDITIONING	NUMBER TESTED	FAILURE RATE
Control	30	16.7%
Rough Handling (-50° & 145°F)	52	21.5%
High Humidity (120°F)	15	66.6%
Waterproofness	12	28.3%
Vibration (-50° & 145°F)	12	26.7%
40 Foot Drop	18	5.6%
High Temp. (125° & 160°F)	24	53.3%
Low Temp. (-70° & -45°F)	24	47.9%

Delay time for the control group averaged 5.5 seconds. In most cases, the delay times for the environmental groups were within 0.3 seconds of this, mostly on the low side. The longest delay times were recorded for those flares fired at -70°F which averaged 5.9 seconds from launch to functioning.

Burn time was significantly effected by whether the flare burned in water or on land. The cooling effect of water produced longer burn times than those that impacted on land. Also, those on land burned hotter, often melting the aluminum shell. The average burn times for the control group were 87 seconds in water and 74 seconds on land. The averages for all those tested were 86 seconds in water. Low temperature conditioning did not effect burn time but high temperature (125°F) conditioning and firing while hot shortened burn time by about 6 to 8 seconds.

Table III contains the average burn times for the different colors for comparison to each other. They are separated into two groups; those that burned in water and those that burned on land. The averages combine the burn times for all environmental groups including the control group.

TABLE III. AVERAGE BURN TIMES FOR EACH COLOR

	IN WATER			ON LAND		
	GREEN	RED	YELLOW	GREEN	RED	YELLOW
BURN TIME (SEC.)	83	83	91	76	78	80
NO. AVERAGED	31	45	34	11	8	11

Range was significantly effected by wind conditions due to the altitude at which normal functioning occurred. When the ballute opened, deceleration occurred so that with no wind, the flare fell straight down. With a moderate breeze (6 mph), however, the range could be extended or decreased, depending on direction by 15 to 25 meters. With a launch angle of 45^{o} and with no wind, a range of about 260 meters could be expected. The environmental conditioning which most effected range was that of high temperature (160^{o}F). Although these were tested during a moderate head wind of about 6 mph, the resulting average range of 220 meters indicated a loss of about 40 meters, a greater range decrease than expected.

Most cartridges tested were stable in flight. About 10% of those fired appeared to wobble in flight between launch and functioning but the slight instability did not effect range or operation.

There were no misfires at launch as all cartridges fired and the cases were extracted normally.

E. Test Data

Included in this section is a tabulation of the performance firing test results for all environmentally conditioned cartridges and for the control cartridges. Presented are pre-firing conditioning for each round; delay time, burn times, range, flight characteristics, flotation characteristics, and any unusual observations. Unless otherwise specified, the altitude at functioning was 1/8 to 1/3 descended from the apex of the trajectory. The burn time is that of the actual visible signal.

All test firing was conducted at General Environments Corporation, Hartwood, Virginia from 29 March 1973 to 6 April 1973.

TABLE IV. TEST DATA

Control Round Number	Color	Environmental Group Control Rounds Were Fired With	Range To Pond (M)	Control Performance Tests					
				Delay Time (sec)	Burn Time (sec)	Range (M)	Flight Characteristics	Flotation Characteristics	Observations
C1	Red	Rough Handling & Vibration	240	5.0	76	249	Stable	Missed pond; short, left	
C2	Red	↓	↓	5.2	62	260	↓	Sank	
C3	Green	↓	↓	---	--	320	↓	Missed pond; long	Function, but no ejection
C4	Green	↓	↓	5.2	87	255	↓	OK	
C5	Red	Rough Handling & Vibration	240	5.2	88	240	↓	OK	
C6	Red	40 Foot Drop	215	6.1	75	256	↓	Missed pond; right	Gusting wind, rain
C7	Green	↓	↓	6.0	69	265	↓	Missed pond; right	Gusting wind, rain
C8	Green	↓	↓	5.9	84	267	↓	Missed pond; right	
C9	Red	↓	↓	5.5	90	251	↓	On side	Poor color
C10	Green	40 Foot Drop	↓	5.8	84	265	↓	On side	Loud burn, poor color
C11	Red	Waterproofness, 4 Hr. Group	↓	5.0	71	270	↓	Missed pond; right	Strong crosswind
C12	Green	Waterproofness, 4 Hr. Group	↓	5.9	79	276	↓	OK	Function, 1/2 descended
C13	Green	High Temperature (125°F)	↓	5.0	76	260	↓	OK	
C14	Green	↓	↓	5.5	73	270	↓	Missed pond; left	Wind shift
C15	Green	↓	↓	5.5	73	280	↓	Missed pond; left	
C16	Yellow	↓	215	5.4	74	320	↓	Missed pond; long	Following wind
C17	Yellow	High Temperature (125°F)	240	5.8	90	270	↓	OK	
C18	Green	High Humidity	↓	6.0	--	320	↓	Missed pond; long	Function, but no ejection
C19	Yellow	High Humidity	↓	5.6	--	259	↓	Sank	
C20	Yellow	High Temperature (160°F)	↓	5.1	92	282	↓	OK	
C21	Yellow	↓	↓	5.3	96	266	↓	OK	
C22	Yellow	↓	240	6.0	95	261	↓	OK	
C23	Yellow	↓	215	5.1	87	250	↓	OK	
C24	Yellow	High Temperature (160°F)	↓	5.4	90	225	Stable	OK	
C25	Yellow	Waterproofness, 48 Hr. Group	↓	5.1	100	235	Slight Wobble	OK	
C26	Red	Low Temperature (-70°F)	↓	5.0	81	270	Stable	OK	
C27	Red	Low Temperature (-45°F)	↓	5.5	77	237	↓	OK	
C28	Red	↓	↓	5.6	86	270	↓	OK	
C29	Red	↓	↓	5.5	83	264	↓	OK	
C30	Yellow	Low Temperature (-45°F)	215	5.8	83	263	Stable	OK	

TABLE IV. TEST DATA (continued)

No.	Color	Conditioning	Saved For Recoil Tests	Distance to Pond (M)	Performance Tests: Delay Time (sec)	Burn Time (sec)	Range (M)	Flight Characteristics	Flotation Characteristics	Observations
1	Green	7 Foot Drop (-50°F)		215	6.0	83	240	Slight wobble	OK	Function, 1/2 descended
2	Red			↓	6.0	84	263	Stable	OK	
3	Yellow			215	6.0	91	224	Slight wobble	OK	
4	Green		X							
5	Red		X							
6	Yellow		X							
7	Green	Loose Cargo Axis Paral.		215	5.3	80	242	Slight wobble	OK	
8	Red			↓	5.0	79	236	Stable	OK	
9	Yellow			215	5.3	91	249	Slight wobble	OK	
10	Green		X							
11	Red		X							
12	Yellow		X							
13	Green	5 Foot Drop, Horiz.		215	5.5	--	250	Stable	Sank	Dent on body near nose
14	Red	Base			6.0	80	270	Stable	OK	
15	Yellow	Nose			5.2	93	250	Stable	OK	
16	Green	45° base			5.3	84	261	Slight wobble	OK	
17	Red	45° nose			5.0	82	235	Stable	OK	Turned on side after burn
18	Yellow	Horiz.		↓	4.9	94	236	Stable	OK	
19	Green	Base		215	---	--	330	Stable	Missed pond; long	No function
20	Red	Nose	X							
21	Yellow	45° base	X							
22	Green	(-50°F) 7 Foot Drop Loose Cargo Axis Paral 5 Ft. Drop, 45° nose	X							

Conditions

Temp: 45° to 50°F

Wind: Direction of Fire

Wind 0 to 10 mph

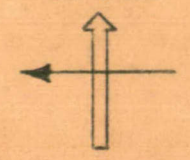
TABLE IV. TEST DATA (continued)

No.	Color	Conditioning	Saved For Recoil Tests	Distance to Pond (M)	Performance Tests: Delay Time (sec)	Burn Time (sec)	Range (M)	Flight Characteristics	Flotation Characteristics	Observations
23	Red	7 Foot Drop (-50°F)		215	5.0	84	241	Stable	Slight leak; stayed afloat	
24	Yellow			↓	6.0	--	254	Stable	Sank	Ballute wobbled after opening
25	Green			215	5.2	82	232	Stable	OK	
26	Red		X							
27	Yellow		X							
28	Green		X							
29	Red	Loose Cargo Axis Perpen.		215	5.1	82	233	Stable	OK	
30	Yellow			↓	4.6	96	248	Stable	OK	
31	Green			215	6.2	78	270	Slight wobble	Missed pond; long	Function, 1/2 descended
32	Red		X							
33	Yellow		X							
34	Green		X							
35	Red	5 Foot Drop, Horiz.		215	5.8	86	277	Stable	OK	
36	Yellow	Base		↓	5.2	54	250	↓	Sank; afloat after 50 sec.	
37	Green	Nose			---	--	325		Missed pond; long	No function
38	Red	45° base			5.1	84	244		OK	
39	Yellow	45° nose			4.5	92	224	Stable	OK	
40	Green	45° nose			6.1	80	255	Slight wobble	OK	Dent on body near nose
41	Red	45° base		215	5.3	75	225	Stable	Slight leak; stayed afloat	
42	Yellow	Nose	X							
43	Green	Base	X							
44	Red	(-50°F) 7 Foot Drop Loose Cargo Axis Perpen 5 Foot Drop, Horiz.	X							

Conditions

Temp: 45° to 50°F

Wind: Direction of Fire



Wind 0 to 10 mph

TABLE IV. TEST DATA (continued)

No.	Color	Conditioning	Saved For Recoil Tests	Distance to Pond (M)	Performance Tests: Delay Time (sec)	Burn Time (sec)	Range (M)	Flight Characteristics	Flotation Characteristics	Observations
45	Yellow	(145°F) 7 Foot Drop		215	5.3	90	275	Stable	OK	
46	Green			↓	5.3	85	237	Stable	OK	
47	Red			215	4.9	36	240	Stable	Sank after 60 sec.	
48	Yellow		X							
49	Green		X							
50	Red		X							
51	Yellow	Loose Cargo Axis Paral.		215	5.0	95	226	Stable	OK	
52	Green			↓	5.2	86	226	Stable	OK	
53	Red			215	5.1	83	242	Stable	OK	
54	Yellow		X							
55	Green		X							
56	Red		X							
57	Yellow	5 Foot Drop, Horiz		240	6.0	74	242	Stable	Missed pond; short	
58	Green	Base		215	5.8	80	225	↓	Missed pond; long	
59	Red	Nose		240	5.0	82	263		OK	
60	Yellow	45°base		240	5.0	81	235		Missed pond; short	
61	Green	45°nose		215	---	--	310		Missed pond; long	No function
62	Red	Horiz		↓	5.5	81	262		OK	
63	Yellow	Base		215	5.5	85	249	Stable	OK	
64	Green	Nose	X							
65	Red	45°base	X							
66	Yellow	(145°F) 7 Foot Drop Loose Cargo Axis Paral. 5 Foot Drop, 45°nose	X							

Conditions

Temp: 45° to 50°F

Wind: Direction of Fire

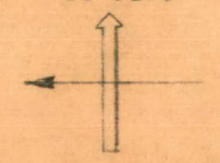


TABLE IV. TEST DATA (continued)

No.	Color	Conditioning	Saved for Recoil Tests	Distance to Pond (M)	Performance Tests: Delay Time (sec)	Burn Time (sec)	Range (M)	Flight Characteristics	Flotation Characteristics	Observations
67	Green	(145°F) 7 Foot Drop		215	5.5	83	239	Bad Wobble	OK	
68	Red			↓	6.0	79	242	Stable	OK	
69	Yellow			215	5.5	95	240	Slight wobble	On side	Poor color
70	Green		X							
71	Red		X							
72	Yellow		X							
73	Green	Loose Cargo Axis Perpen		215	5.8	73	272	Stable	Missed pond; long	Function, 1/2 descended
74	Red			↓	5.5	83	257	Stable	OK	
75	Yellow			215	4.9	94	219	Stable	Missed pond; short	Low sound at launch
76	Green		X							
77	Red		X							
78	Yellow		X							
79	Green	5 Foot Drop, Horiz		215 ↓	5.0	--	242	Stable	Sank	
80	Red	Base		↓	5.8	82	242	↓	OK	
81	Yellow	Nose		215	5.1	94	254		OK	Poor color
82	Green	45° base		240	5.0	82	244		Missed pond; left	Gusting crosswind
83	Red	45° nose		215	5.0	83	230		OK	
84	Yellow	45° nose		215	5.5	98	252		On side	
85	Green	45° base		240	5.0	87	265	Stable	OK	
86	Red	Nose	X							
87	Yellow	Base	X							
88	Green	(145°F) 7 Foot Drop, Loose Cargo Axis Perpen, 5 Foot Drop, Horiz	X							

Conditions

Temp: 45° to 50°F

Wind: Direction of Fire

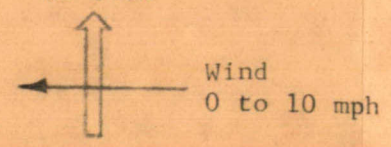


TABLE IV. TEST DATA (CONTINUED)

No.	Color	Conditioning	Saved For Recoil Tests	Distance to Pond (M)	Performance Tests					
					Delay Time (sec)	Burn Time (sec)	Range (M)	Flight Characteristics	Flotation Characteristics	Observations
89	Green	High Humidity		240	---	---	330	Stable	Missed pond; long	No function
90	Red				5.3	80	265		OK	
91	Yellow				6.1	21	255		Turned over, sank after 35 sec	
92	Green				6.0	---	325		Missed pond; long	Function, but no ejection
93	Red				5.4	79	264		OK	Poor color
94	Yellow				5.8	92	239		Missed pond; short	
95	Green				---	---	320		Missed pond; long	No function
96	Red				5.3	66	255		Floated 83 sec., sank, surfaced for 27 sec. Burn.	
97	Yellow				5.8	82	255		OK	
98	Green				6.1	80	266		OK	
99	Red				6.2	---	330		Missed pond; long	Function, but no ejection
100	Yellow				5.8	85	255		OK	
101	Green				5.5	---	250		Sank	
102	Red				5.1	78	275		On side	Poor color
103	Yellow			240	5.5	18	275	Stable	On side; sank in 30 sec	
104	Green		X							
105	Red		X							
106	Yellow	High Humidity	X							

Conditions

Temp: 65°F

Wind: Calm

TABLE IV. TEST DATA (continued)

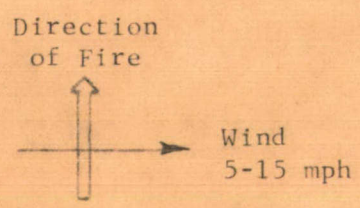
No.	Color	Conditioning	Weight Gain (GM)	Distance to Pond (M)	Performance Tests					
					Delay Time (sec)	Burn Time (sec)	Range (M)	Flight Character-istics	Flotation Characteristics	Observations
107	Green	Waterproofness	.08	215	5.6	85	252	Slight wobble	OK	
108	Red		0*		5.3	73	262	Stable	OK for 60 sec, side afterward	
109	Yellow		.05		5.0	97	247	Bad wobble	OK	
110	Green		0*		5.1	---	250	Stable	Sank	Ballute burned in air
111	Red		0*		5.3	84	268		OK	
112	Yellow		.05		5.3	102	257		OK	
113	Green		.02		4.9	45	240	Stable	On side; sank in 75 sec.	No color
114	Red		0		5.8	79	280	Slight wobble	Missed pond; long	Ballute slow opening
115	Yellow		.02*		5.1	---	330	Stable	Missed pond; long	Function, but no ejection
116	Green		0*		5.1	88	270		Side 30 sec., OK remainder	
117	Red		0		5.0	33	258		Sank for 60 sec., surfaced on side for 55 sec. burn	Poor color
118	Yellow	Waterproofness	0*	215	5.2	102	276	Stable	OK	

*Fired with 4 hour group; others fired with 48 hour group.

Conditions for 4 Hr. Group

Temp: 50°F

Wind:



Conditions for 48 Hr. Group

Temp: 55°F

Wind: Calm

TABLE IV. TEST DATA (continued)

No.	Color	Conditioning	Saved for Recoil Tests	Distance to Pond (M)	Performance Tests: Delay Time (sec)	Burn Time (sec)	Range (M)	Flight Characteristics	Flotation Characteristics	Observations
119	Green	Vibration (-50°F), Axis Paral.		215	5.8	81	259	Stable	OK	
120	Red			↓	5.0	---	330	Stable	Missed pond; long	Function, but no ejection
121	Yellow			215	5.1	69	255	Stable	Sank for 30 sec, resurfaced	Ballute wobbled in flight
122	Green		X							
123	Red		X							
124	Yellow	Axis. Paral.	X							
125	Green	Axis Perpen.		215	5.0	83	250	Stable	OK	
126	Red			↓	5.0	79	250	Stable	OK	
127	Yellow			215	5.2	89	252	Stable	OK	
128	Green		X							
129	Red		X							
130	Yellow	(-50°F) Axis Perpen	X							
131	Green	(145°F) Axis Paral.		215 ↓	5.0	81	245	Slight wobble	OK	
132	Red				5.0	83	235	Slight wobble	OK	
133	Yellow			215	5.0	86	230	Wobble	OK	
134	Green		X							
135	Red		X							
136	Yellow	Axis Paral	X							
137	Green			215	---	---	315	Stable	Missed pond; long	No function
138	Red			↓	5.1	82	234	Bad Wobble	OK	
139	Yellow			215	5.5	86	260	Stable	OK	
140	Green		X							
141	Red		X							
142	Yellow	Vibration (145°F) Axis Paral	X							

Conditions

Temp: 55°F

Wind: Direction of Fire

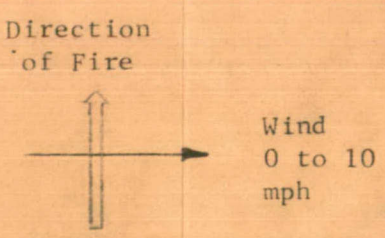
Wind
0 to 6 mph

TABLE IV. TEST DATA (continued)

No.	Color	Conditioning		Range to Pond (M)	Performance Tests: Decay Time (sec)	Burn Time (sec)	Range (M)	Flight Characteristics	Flotation Characteristics	Observations
143	Green	40 Ft. Drop	Bottom Down	215	5.3	84	248	Stable	OK	
144	Red				5.1	83	261		OK	
145	Yellow				5.9	96	280		Missed pond; long, left	
146	Green				5.9	85	247		OK	
147	Red				4.9	86	242		OK	
148	Yellow		Bottom Down		5.3	90	259		OK	
149	Green		Top Down		5.2	79	270	Stable	Missed pond; right	Gusting 10 mph crosswind
150	Red				4.9	84	240	Slight wobble	On side 60 sec. then straightened	
151	Yellow				5.1	---	330	Stable	Missed pond; long	Function, but no ejection
152	Green				4.9	83	252		OK	Load hiss at burn
153	Red				5.9	86	272		OK	
154	Yellow		Top Down		5.9	85	269		OK	
155	Green		Top Corner Down		5.3	89	260		OK	
156	Red				5.5	85	275		Missed pond, right	Gusting 10 mph crosswind
157	Yellow				5.3	73	270		Missed pond, right	Gusting 10 mph crosswind
158	Green				5.3	90	265		OK	
159	Red				5.3	88	262	Stable	Side	Poor color
160	Yellow	40 Ft. Drop	Top corner down	215	6.1	84	290	Slight wobble	Missed pond; long	Explosion; ballute & projectile separated after 60 sec. burn

Conditions: Temp: 50° to 60°F

Wind:

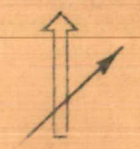


No.	Color	Conditioning	Saved for Recoil Tests	Distance to Pond (M)	Performance Tests: Delay Time (sec)	Burn Time (sec)	Range (M)	Flight Characteristics	Flotation Characteristics	Observations
161	Green	High Temp. (125°F)		240	5.5	79	274	Stable	OK	
162	Red				5.8	84	274		OK	
163	Yellow				5.6	66	295		Missed pond; long	Gusting tailwind 10 mph
164	Green				6.0	73	263		On side	Poor color
165	Red				5.5	80	268		OK	
166	Yellow				5.3	---	276		Sank	Ballute burned in flight
167	Green				5.6	82	276	Stable	OK	Loud pop during burn
168	Red				5.5	82	269	Slight wobble	OK	
169	Yellow				5.0	79	275	Stable	OK	
170	Green				---	---	330		Missed pond; long	No function
171	Red				5.0	79	295		OK	
172	Yellow			240	5.5	---	288	Stable	Sank	
173	Green		X							
174	Red		X							
175	Yellow		X							
176	Green		X							
177	Red		X							
178	Yellow	High Temp. (125°F)	X							

Conditions

Temp: 55°F

Wind: Direction of Fire



Wind 5-10 mph

TABLE IV. TEST DATA (continued)

No.	Color	Conditioning	Saved for Recoil Tests	Distance to Pond (M)	Performance Tests: Delay Time (sec)	Burn Time (sec)	Range (M)	Flight Characteristics	Flotation Characteristics	Observations
179	Green	High Temp. (160°F)		240	---	---	330	Stable	Missed pond; long	No function
180	Red			240	5.5	77	228		short	
181	Yellow			215	---	---	330		long	No function
182	Green				5.9	---	330		long	Function, but no ejection
183	Red				5.0	81	225		left	
184	Yellow				---	---	330		long	No function
185	Green			215	5.0	70	235		left	
186	Red			240	---	---	330		long	No function
187	Yellow			240	6.1	---	320		long	Function, but no ejection
188	Green			215	5.1	---	330		long	Function, but no ejection
189	Red			240	5.5	79	225		short	
190	Yellow			240	5.5	68	190	Stable	Missed pond; short	
191	Green		X							
192	Red		X							
193	Yellow		X							
194	Green		X							
195	Red		X							
196	Yellow	High Temp. (160°F)	X							

Conditions

Temp: 65° to 70°F

Wind: Direction of Fire

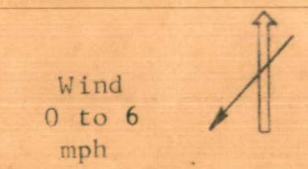


TABLE IV. TEST DATA (continued)

No.	Color	Conditioning	Distance to Pond (M)	Performance Tests: Delay Time (sec)	Burn Time (sec)	Range (M)	Flight Characteristics	Flight Characteristics	Observations
197	Green	Low Temp. (-70°F)	215	6.2	78	290	Bad wobble	Missed pond; long	Late open caused overshoot
198	Red			6.0	---	275	Stable	Sank	Function, but no ejection
199	Yellow			5.8	---	305		Missed pond; long	Function, but no ejection
200	Green			6.0	---	310	Stable	Missed pond; long	Function, but no ejection
201	Red			5.8	91	260	Slight wobble	OK	Function 1/2 descended
202	Yellow			6.0	---	310	Stable	Missed pond; long	Function, but no ejection
203	Green			6.0	---	300		Missed pond; long	Function, but no ejection
204	Red			5.8	---	300		Missed pond; long	Function, but no ejection
205	Yellow			6.0	---	275		Sank; surfaced after burn	Ejection, but ballute did not open
206	Green			5.5	81	250		OK	
207	Red			5.5	94	252	Stable	OK	Function 1/2 descended
208	Yellow	(-70°F)		5.8	85	273	Slight wobble	OK	
209	Green	(-45°F)		5.1	88	234	Stable	OK	
210	Red			5.3	91	240		OK	
211	Yellow			5.8	88	285		OK	
212	Green			5.5	91	256		OK	
213	Red			5.5	94	247		OK	
214	Yellow			5.5	90	270		OK	
215	Green			6.1	79	274		OK	Bright color; loud hiss
216	Red			5.5	90	265		OK	
217	Yellow			6.0	---	330	Stable	Missed pond; long	Function, but no ejection
218	Green			5.8	---	270	Slight wobble	Sank	
219	Red			5.9	87	240	Slight wobble	OK	Ballute tumbled in flight
220	Yellow	Low Temp. (-45°F)	215	6.1	78	295	Stable	Missed pond; long	Late open caused overshoot

Conditions for -70°F Group

Temp: 60°F

Wind: Calm

Conditions for -45°F Group

Temp: 45°F

Wind: Calm

APPENDIX I

ENVIRONMENTAL TESTING

REPORT NO. A-4504

DATE 11 April 1973

REPORT

ON

ENVIRONMENTAL TESTING

OF

40MM FLOATING FLARE

FOR

AAI CORPORATION
P. O. BOX 6825
COCKEYSVILLE, MARYLAND 21030

GENERAL ENVIRONMENTS CORPORATION
HARTWOOD, VIRGINIA 22471

	PREPARED	CHECKED	APPROVED
BY	A. A. Ellis	W. P. Dorgeloh	C. M. Hening
SIGNED	A. A. Ellis	W. P. Dorgeloh	C. M. Hening
DATE	16 April 1973	19 April 1973	19 April 1973

FORM NO. 113

TABLE OF CONTENTS

ADMINISTRATIVE DATA

PURPOSE OF TEST

The purpose of the test program was to assure that the 40MM Floating Flare could comply with the environmental treatment as described herein and as required by AAI Corporation purchase order 411856.

TEST CONDUCTED FOR

AAI Corporation
P. O. Box 6825
Cockeysville, Maryland 21030

TEST CONDUCTED BY

General Environments Corporation
Pyrotechnic Laboratory
Hartwood, Virginia 22471

TEST ARTICLE DESCRIPTION

40MM Floating Flare approximately 5.25 inches long and weighing approximately eight (8) ounces with an aluminum projectile body, plastic windshield and aluminum cartridge case which houses the high-low propulsion system used to propel the projectile.

MANUFACTURER OF TEST ARTICLE

U. S. Army Land Warfare Laboratory
Aberdeen Proving Ground, Maryland 21005

APPLICABLE DOCUMENTS

1. AAI Corporation purchase order 411856
2. AAI Corporation Test Plan for 40MM Floating Flare 54109-70006
3. MTP 4-2-601
4. MTP 4-2-602
5. MTP 4-2-804
6. MTP 4-2-820

QUANTITY OF TEST ARTICLES

Two-hundred-fifty (250) 40MM Floating Flare cartridges

EXPLOSIVE CLASSIFICATION

Special Fireworks - Class B explosive hazard

SECURITY CLASSIFICATION

Unclassified

DATE TEST COMPLETED

5 April 1973

DISPOSITION OF TEST ARTICLES

At the conclusion of the test program, the test articles not expended by AAI Corporation representatives were removed from the testing facility by AAI Corporation transport.

ABSTRACT

This report delineates the conduct of environmental testing of two-hundred-fifty (250) 40MM Floating Flares for AAI Corporation, Cockeysville, Maryland.

Seven Foot Package Drop, Loose Cargo, Five Foot Drop, High Humidity (Steady State), Waterproofness, Vibration, Forty Foot Drop, High Temperature and Low Temperature tests were conducted to assure design adequacy and structural integrity of the test articles.

Pre-test examination revealed no apparent indication of deterioration and/or damage of the test articles as a result of transport. Detachment of the plastic windshield and denting occurred as a result of the Drop Tests.

Upon completion of the test program, the test articles not expended by AAI Corporation representatives were removed from the testing facility by AAI Corporation transport.

FACTUAL DATA

1.0 TEST APPARATUS

1.1 Seven Foot Package Drop Test

A. Drop Tower & electromagnetic release
General Environments Corporation

1.2 Loose Cargo

A. Package Tester
LAB
Model: SC1000

B. Electronic Counter
Hewlett Packard
Model: 521CR
Calibration Due: 13 September 1973

1.3 Five Foot Drop

A. Drop Tower & electromagnetic release
General Environments Corporation

1.4 High Humidity (Steady State)

A. Humidity Chamber
Bemco, Inc.
Model: FW100/350-8

B. Recorder-Controller
Bristol Company
Model: 2T500FFS2-1A
Calibration Due: 20 August 1973

1.5 Vibration

A. Vibration Exciter
M-B Electronics
Model: C-150

B. Power Amplifier
M-B Electronics
Model: 4450

C. Servo Oscillator
Bruel & Kjaer
Model: N575/N576-1028

1.5 Vibration (continued)

D. Accelerometer
Endevco
Model: 2271AM20
Calibration Due: 3 June 1973

E. Accelerometer Amplifier
Unholtz Dickie
Model: 11G
Calibration Due: 6 June 1973

F. Oscilloscope
Tektronix
Model: RM35A
Calibration Due: 5 June 1973

G. Thermal Shroud
Wyle Manufacturing Corporation
Model: TE-100-64

1.6 Forty Foot Drop

A. Drop Tower & electromagnetic release
General Environments Corporation

1.7 High Temperature

A. Thermal Chamber
Standard Cabinet Company
Model: STAHC/64FS

B. Recorder-Controller
Bristol Company
Model: 2T500FFS4-1A
Calibration Due: 20 August 1973

C. Thermal Chamber
Standard Cabinet Company
Model: LHHC/27FS

D. Recorder-Controller
Bristol Company
Model: 2T500FFS4-43B-G1
Calibration Due: 27 September 1973

1.8 Low Temperature

A. Thermal Chamber
Standard Cabinet Company
Model: STACA/36FS

B. Recorder-Controller
Honeywell
Model: 602C44-CC-24-III-93
Calibration Due: 29 September 1973

2.0 TEST PROCEDURE

2.1 General

The two-hundred-fifty (250) 40MM Floating Flares were subjected to the environmental test program described in Table I and conducted in accordance with applicable documents No. 1 thru No. 6.

TABLE I

M2A1 Box No.		Box #1	Box #2	Box #3	Box #4
Temperature		-50°F	-50°F	145°F	145°F
7 Foot Drop	Flare No.	1 thru 22	23 thru 44	45 thru 66	67 thru 88
	Orientation	In wire bound container and dropped Horizontal, base down, nose down, 45° base down, 45° nose down		In wire bound container and dropped same as 1 & 2	
Removed after 7 Foot Drop		1 thru 6	23 thru 28	45 thru 50	67 thru 72
Loose Cargo	Flare No.	7 thru 22	29 thru 44	51 thru 66	73 thru 88
	Orientation	Parallel to Bounce	Perpendicular to Bounce	Parallel to Bounce	Perpendicular to Bounce
Removed after Loose Cargo		7 thru 12	29 thru 34	51 thru 56	73 thru 78
5 Foot Drop	Flare No. & Orientation	13 Horiz. 14 Base Dwn 15 Nose Dwn 16 45° Base Dwn 17 45° Nose Dwn 18 Horiz. 19 Base Dwn 20 Nose Dwn 21 45° Base Dwn 22 45° Nose Dwn	35 Horiz. 36 Base Dwn 37 Nose Dwn 38 45° Base Dwn 39 45° Nose Dwn 40 45° Nose Dwn 41 45° Base Dwn 42 Nose Dwn 43 Base Dwn 44 Horiz.	57 Horiz. 58 Base Dwn 59 Nose Dwn 60 45° Base Dwn 61 45° Nose Dwn 62 Horiz. 63 Base Dwn 64 Nose Dwn 65 45° Base Dwn 66 45° Nose Dwn	79 Horiz. 80 Base Dwn 81 Nose Dwn 82 45° Base Dwn 83 45° Nose Dwn 84 45° Nose Dwn 85 45° Base Dwn 86 Nose Dwn 87 Base Dwn 88 Horiz.

TABLE I (continued)

Humidity (Steady State)		Flare No. 89 thru 106					
Waterproofness		Flare No. 107 thru 118					
M2A1 Box No.		Box #1		Box #2		Box #3	Box #4
Temperature		-50°F		-50°F		145°F	145°F
Vibration	Flare No.	119 thru 124		125 thru 130		131 thru 136	137 thru 142
	Orientation	Longitudinal		Transverse		Longitudinal	Transverse
Wood Box No.		Wood Box #1		Wood Box #2		Wood Box #3	
M2A1 Box No.		Box #1	Box #2	Box #3	Box #4	Box #5	Box #6
40 Foot Drop	Flare No.	143,144, 145	146,147, 148	149,150, 151	152,153, 154	155,156, 157	158,159, 160
	Orientation	Bottom Down		Top Down		Bottom Corner Down	
High Temperature		Flare No. 161 thru 196					
Low Temperature		Flare No. 197 thru 220					
Control		Flare No. 221 thru 250					

2.2 Seven Foot Drop Test

The seven foot packaged drop test was conducted in accordance with MTP 4-2-602, Appendix E. Each M2A1 Box containing twenty-two (22) 40MM Floating Flares. Two (2) M2A1 Boxes were contained in one (1) wire bound wood box as specified in Table I and conditioned at -50°F and/or 145°F for a sufficient time to assure complete temperature stabilization. Each of the two (2) wood boxes containing two (2) M2A1 boxes were then dropped horizontal, base down, nose down, 45° base down and 45° nose down from a height of seven (7) feet. At the conclusion of the seven foot packaged drop test, six (6) 40MM Floating Flares were removed from each M2A1 box as specified in Table I.

2.3 Loose Cargo Test

The loose cargo test was conducted in accordance with MTP4-2-602, Appendix A with the exception that loose packages were used rather than loose flares as specified in Table I. Cylinders of equivalent size and weight were added to the M2A1 boxes to compensate for those removed and the thermal conditioning specified in paragraph 2.2 repeated. One (1)

2.3 Loose Cargo Test (continued)

M2A1 box for each temperature was oriented parallel to, and the other M2A1 box perpendicular to, the longitudinal axis of the 40MM Floating Flares and subjected to the loose cargo (bounce) test. At the conclusion of the loose cargo (bounce) test, six (6) 40MM Floating Flares were removed from each M2A1 box as specified in Table I.

2.4 Five Foot Drop Test

The five foot drop test was conducted in accordance with MTP4-2-602, Appendix D. The thermal conditioning specified in paragraph 2.2 was repeated. Ten (10) 40MM Floating Flares from each M2A1 box were individually dropped in the orientations specified in Table I from a height of five (5) feet.

2.5 High Humidity (Steady State)

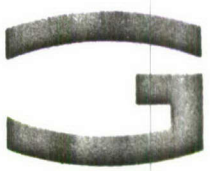
The high humidity test was conducted in accordance with MTP4-2-820, Paragraph 6.2.1. The eighteen (18) 40MM Floating Flares specified in Table I was subjected to 120°F, 95% relative humidity for a time period of three-hundred-sixty (360) hours, then returned to standard ambient conditions and examined for deterioration and/or damage.

2.6 Waterproofness Test

The twelve (12) 40MM Floating Flares specified in Table I were precisely weighed and immersed in three (3) feet of fresh water at 70°F (± 5°F) for a time period of two (2) hours. The twelve (12) test articles were then removed from the water, wiped free of moisture and allowed to air dry for a time period of one (1) hour. The twelve (12) test articles were then precisely weighed to determine their acquisition of moisture.

2.7 Vibration Test

The vibration test was conducted in accordance with MTP4-2-804 to simulate 1000 miles of two (2) wheeled trailer transport and one (1) hour of aircraft flight.



2.7 Vibration Test (continued)

Six (6) 40MM Floating Flares were packaged in each of four (4) M2A1 boxes along with cylinders of equivalent size and weight to simulate the gross weight and packing of each box as specified in Table I. The M2A1 boxes in which the test articles were packaged were thermally conditioned at -50°F and/or 145°F as specified in Table I and paragraph 2.2. The thermal conditions were maintained during vibration, with M2A1 boxes No. 1 and No. 3 having test articles parallel to the direction of excitation and M2A1 boxes No. 2 and No. 4 having test articles perpendicular to the direction of excitation. The vibration schedule is presented in Table II for one (1) hour and fifteen (15) minutes.

TABLE II

	Frequency (Hz)	Amplitude
(Ground)	5.5 - 7	1.0 in. d.a.
	7 - 37	2.5 g's
(Aircraft)	37 - 52	0.036 in. d.a.
	52 - 500	5.0 g's

Sweep rate 7.5 min. from lower to upper frequency

2.8 Forty Foot Drop Test

The forty foot drop test was conducted in accordance with MTP 4-2-601. Three (3) 40MM Floating Flares were packaged in each of six (6) M2A1 boxes along with cylinders of equivalent size and weight to simulate the gross weight and packing of each box and two (2) M2A1 boxes were contained in one (1) wire bound wood box as specified in Table I. Each of the three (3) wood boxes containing two (2) M2A1 boxes each were then dropped bottom down, top down and top corner down from a height of forty (40) feet onto a steel plate. At the conclusion of each forty foot drop, the test articles were examined and photographed.

2.9 High Temperature Storage Test

Thirty-six (36) 40MM Floating Flares were subjected to a cycled thermal exposure for seven (7) days as specified in Table III.

TABLE III

Six (6) hours	94°F and 15%-20% R.H.
Six (6) hours	increasing to 160°F less than 5% R.H.
Four (4) hours	160°F less than 5% R.H.
Eight (8) hours	decreasing to 94°F
Note: Cycle for one (1) day	

Following the seven (7) days cycled thermal exposure, the temperature was increased to 125°F and maintained for a time period of sixteen (16) hours. At the conclusion of the sixteen (16) hours exposure to 125°F, eighteen (18) 40MM Floating Flares were removed, the temperature was increased to 160°F and maintained for a time period of eight (8) hours. At the time a portion of the test articles were withdrawn and at the conclusion of the high temperature storage test, the test articles were examined for indication of damage and/or deterioration.

2.10 Low Temperature Storage Test

Twenty-four (24) 40MM Floating Flares were subjected to three (3) days storage at -70°F. Following the three (3) days exposure at -70°F, twelve (12) test articles were removed, the temperature increased to -45°F and maintained for twenty-four (24) hours. At the time a portion of the test articles were withdrawn and at the conclusion of the low temperature storage test, the test articles were examined for indication of damage and/or deterioration.

2.11 Performance Firing Test

AAI Corporation representatives conducted the entire performance firing test at General Environments Corporation testing facility. One-hundred-sixty-nine (169) 40MM Floating Flares were fired for performance after having been previously

2.11 Performance Firing Test (continued)

exposed to environmental testing. Twelve (12) Flares withdrawn after the seven foot packaged drop test. Twelve (12) Flares withdrawn after the loose cargo test. Twenty-eight (28) Flares withdrawn after the five foot drop test. Fifteen (15) Flares withdrawn after high humidity test. Twelve (12) Flares withdrawn after water-proofness test. Twelve (12) Flares withdrawn after vibration test. Twenty-four (24) Flares withdrawn after high temperature storage test. Twenty-four (24) Flares withdrawn after low temperature storage test. Thirty (30) Flares designated as control not having been exposed to environmental testing.

3.0 Test Results

3.1 Seven Foot Drop Test

The wire bound wood boxes were broken open, the M2A1 boxes were deformed and the plastic windshields in the forward end of the 40MM Floating Flares were dislodged on impact as a result of the drop test from a height of seven (7) feet.

3.2 Loose Cargo Test

Abrasion of the finish on the M2A1 boxes and the plastic windshields in the forward end of the 40MM Floating Flares were dislodged as a result of the loose cargo (bounce) test with a duration of five (5) minutes on each of six (6) faces of the M2A1 boxes.

3.3 Five Foot Drop Test

Denting of the 40MM Floating Flares resulting from the drop test from a height of five (5) feet is documented in Table IV.

3.3 Five Foot Drop Test (continued)

TABLE IV

Flare No.	Orientation	Temperature (°F)	Result
13	Horizontal	-50	Dent nose & base
14	Base down	-50	Dent base
15	Nose Down	-50	Dent nose
16	45° Base Down	-50	Dent base
17	45° Nose Down	-50	Dent nose
18	Horizontal	-50	Dent nose & base
19	Base Down	-50	Dent base
20	Nose Down	-50	None
21	45° Base Down	-50	Dent base
22	45° Nose Down	-50	Dent nose
35	Horizontal	-50	Dent nose & base
36	Base Down	-50	Dent base
37	Nose Down	-50	None
38	45° Base Down	-50	Dent base
39	45° Nose Down	-50	Dent nose
40	45° Nose Down	-50	Dent nose & base
41	45° Base Down	-50	Dent base
42	Nose Down	-50	None
43	Base Down	-50	None
44	Horizontal	-50	Dent base
57	Horizontal	145	Dent base
58	Base Down	145	None
59	Nose Down	145	Dent nose
60	45° Base Down	145	Dent base
61	45° Nose Down	145	None
62	Horizontal	145	Dent base
63	Base Down	145	None
64	Nose Down	145	None
65	45° Base Down	145	Dent nose
66	45° Nose Down	145	Dent nose
79	Horizontal	145	None
80	Base Down	145	None
81	Nose Down	145	Dent nose
82	45° Base Down	145	Dent base
83	45° Nose Down	145	Dent nose
84	45° Nose Down	145	Dent nose
85	45° Base Down	145	Dent base
86	Nose Down	145	Dent nose
87	Base Down	145	None
88	Horizontal	145	None

3.4 High Humidity (Steady State)

There was no apparent indication of deterioration and/or damage to the 40MM Floating Flares as a result of the high humidity test exposure.

3.5 Waterproofness Test

There was no apparent indication of deterioration and/or damage to the 40MM Floating Flares as result of the waterproofness test. Test articles weight prior to and after testing is documented in Table V.

TABLE V

Flare No.	Weight before (gr)	Weight after (gr)	Gain (gr)
107	277.80	277.88	0.08
108	280.30	280.30	-
109	271.85	271.90	0.05
110	276.50	276.50	-
111	278.80	278.80	-
112	271.10	271.15	0.05
113	276.30	276.32	0.02
114	280.10	280.10	-
115	269.70	269.72	0.02
116	276.00	276.00	-
117	280.20	280.20	-
118	271.85	271.85	-

3.6 Vibration Test

There was no apparent indication of deterioration and/or damage to the 40MM Floating Flares as a result of the vibration test exposure.

3.7 Forty Foot Drop Test

The wire bound wood boxes were broken open and the M2A1 boxes deformed on impact, however there was no apparent indication of deterioration and/or damage to the 40MM Floating Flares as a result of the drop test from a height of forty (40) feet.

3.8 High Temperature Storage Test

There was no apparent indication of deterioration and/or damage to the 40MM Floating Flares as a result of the high temperature storage test exposure.

3.9 Low Temperature Storage Test

There was no apparent indication of deterioration and/or damage to the 40MM Floating Flares as a result of the low temperature storage test exposure.

3.10 Performance Firing Test

General Environments Corporation did not have control of the performance test to be conducted by AAI Corporation representatives. The acquisition of data and test results during firing of the 40MM Floating Flares was the responsibility of AAI Corporation and therefore is not incorporated as a part of this report.

APPENDIX A

Figures

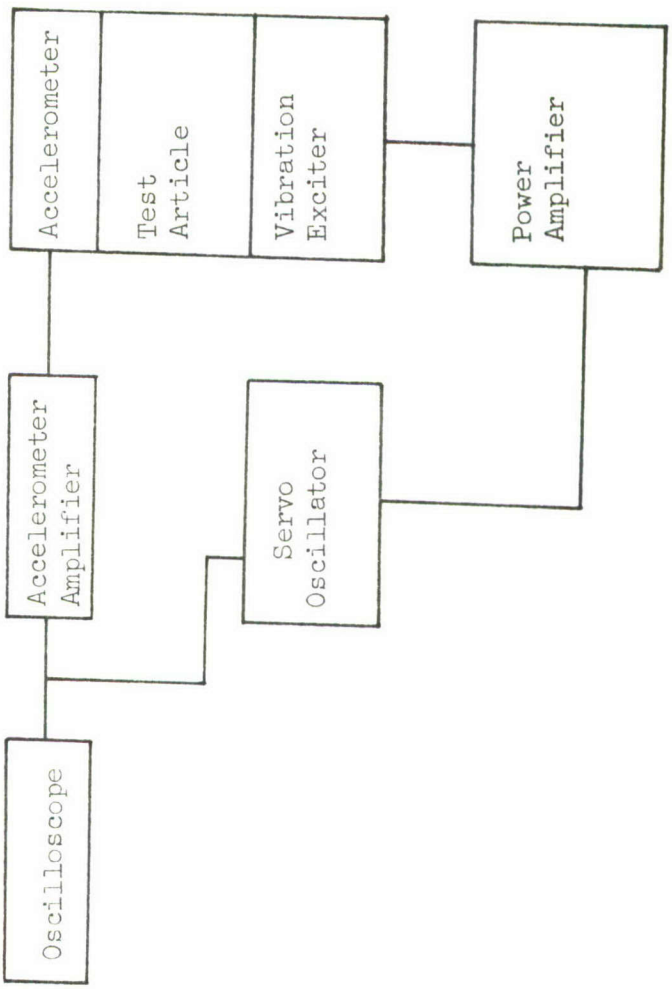
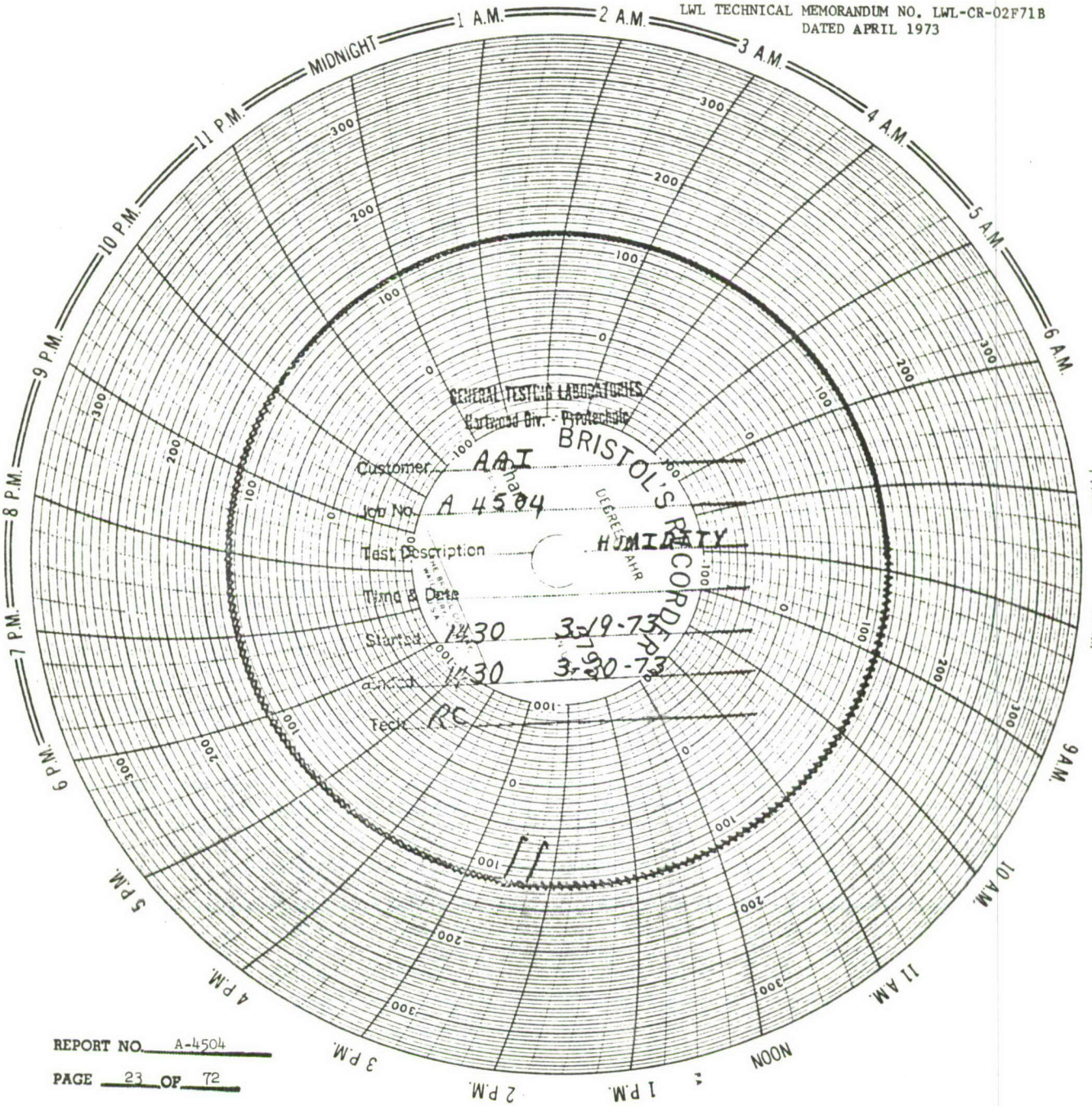


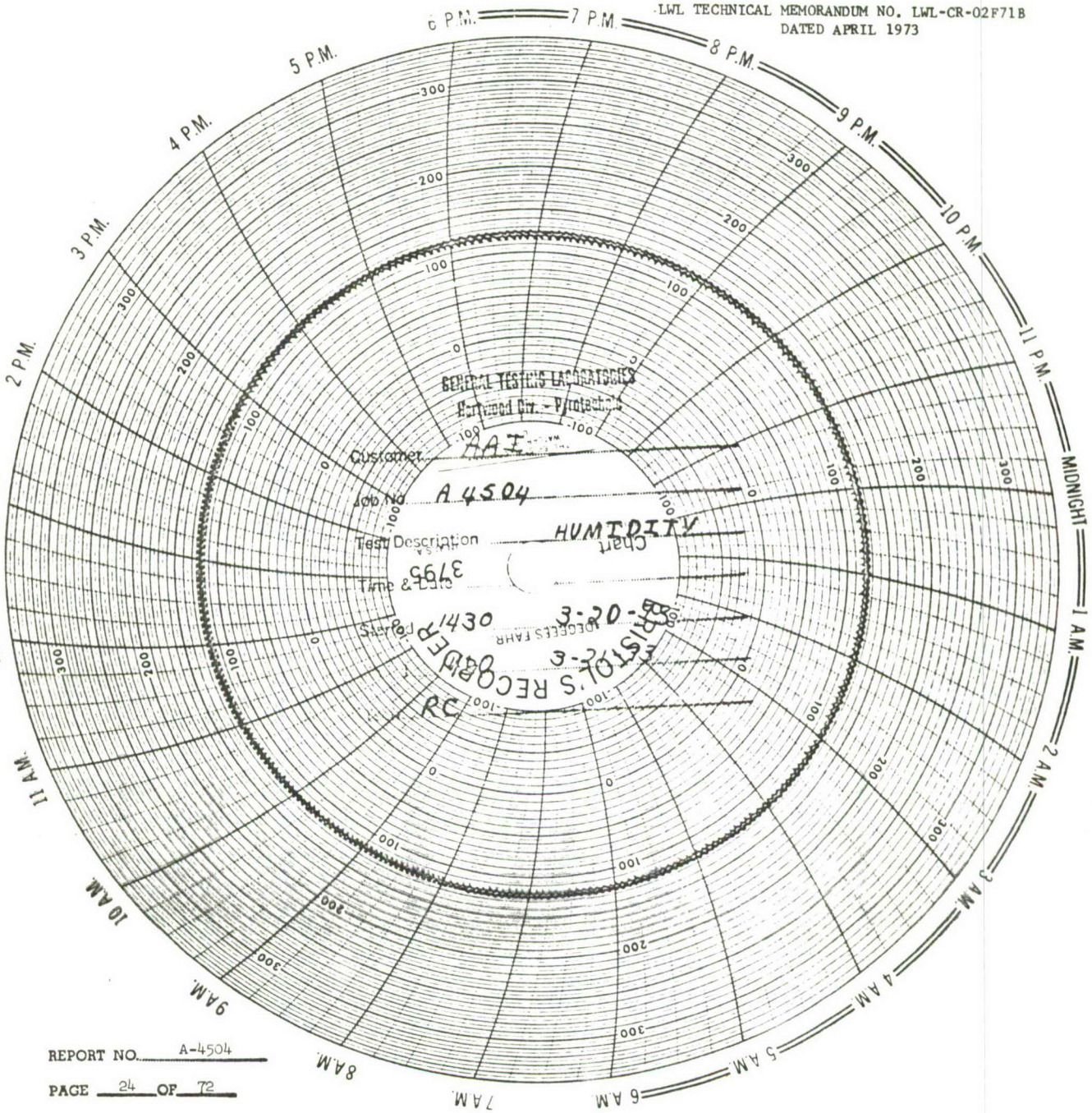
FIGURE I
VIBRATION

APPENDIX B

Test Data

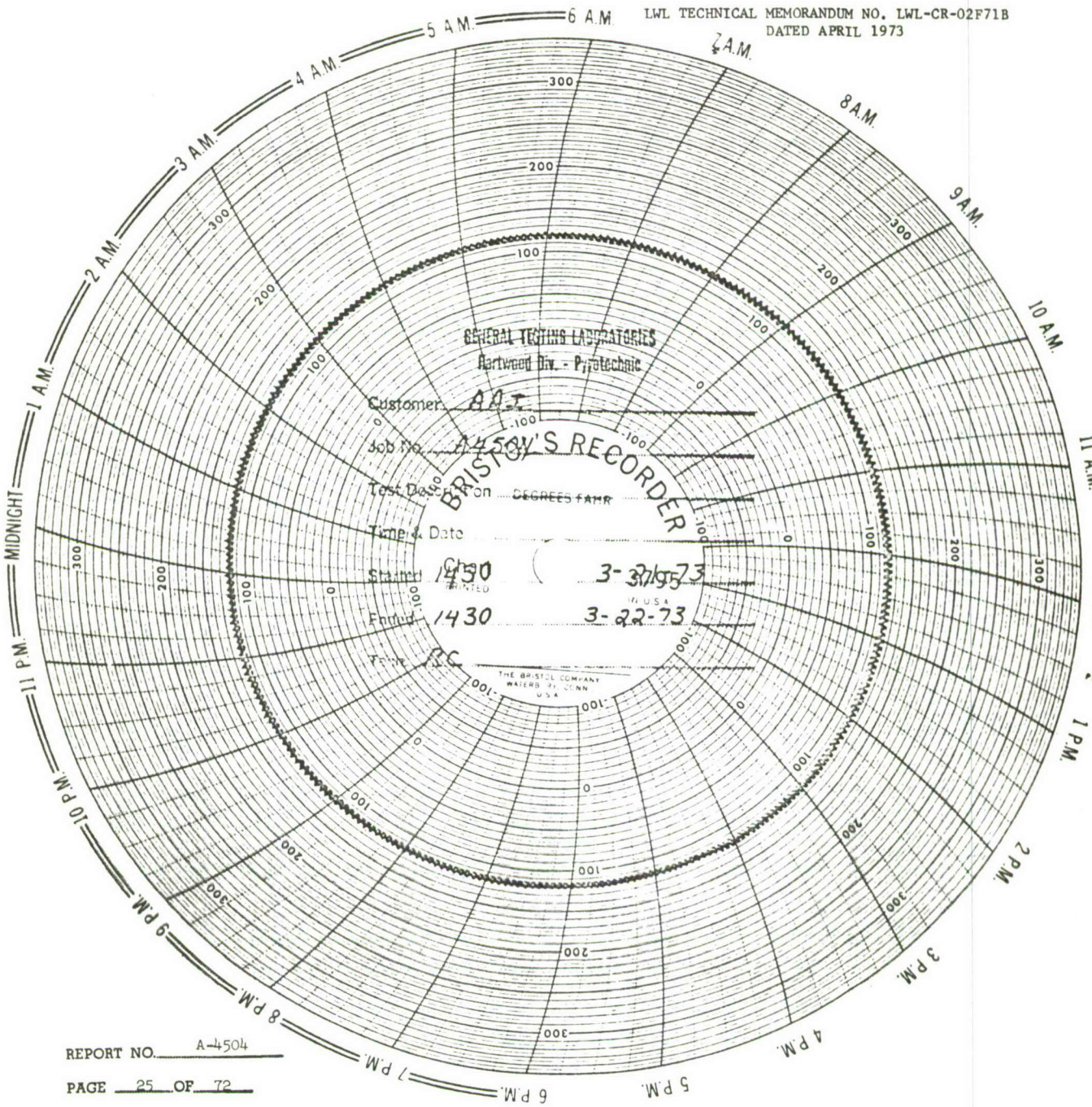
HUMIDITY


GENERAL TESTING LABORATORIES
Carbondale Div. - Bristol Co.
BRISTOL'S RECORDAY
Customer AAI
Job No. A 4504
Test Description HUMIDITY
Time & Date
Started 1430 3-19-73
Finished 1430 3-20-73
Tech RC
1 A.M.
2 A.M.
3 A.M.
4 A.M.
5 A.M.
6 A.M.
7 A.M.
8 A.M.
9 A.M.
10 A.M.
11 A.M.
NOON
1 P.M.
2 P.M.
3 P.M.
4 P.M.
5 P.M.
6 P.M.
7 P.M.
8 P.M.
9 P.M.
10 P.M.
11 P.M.
MIDNIGHT



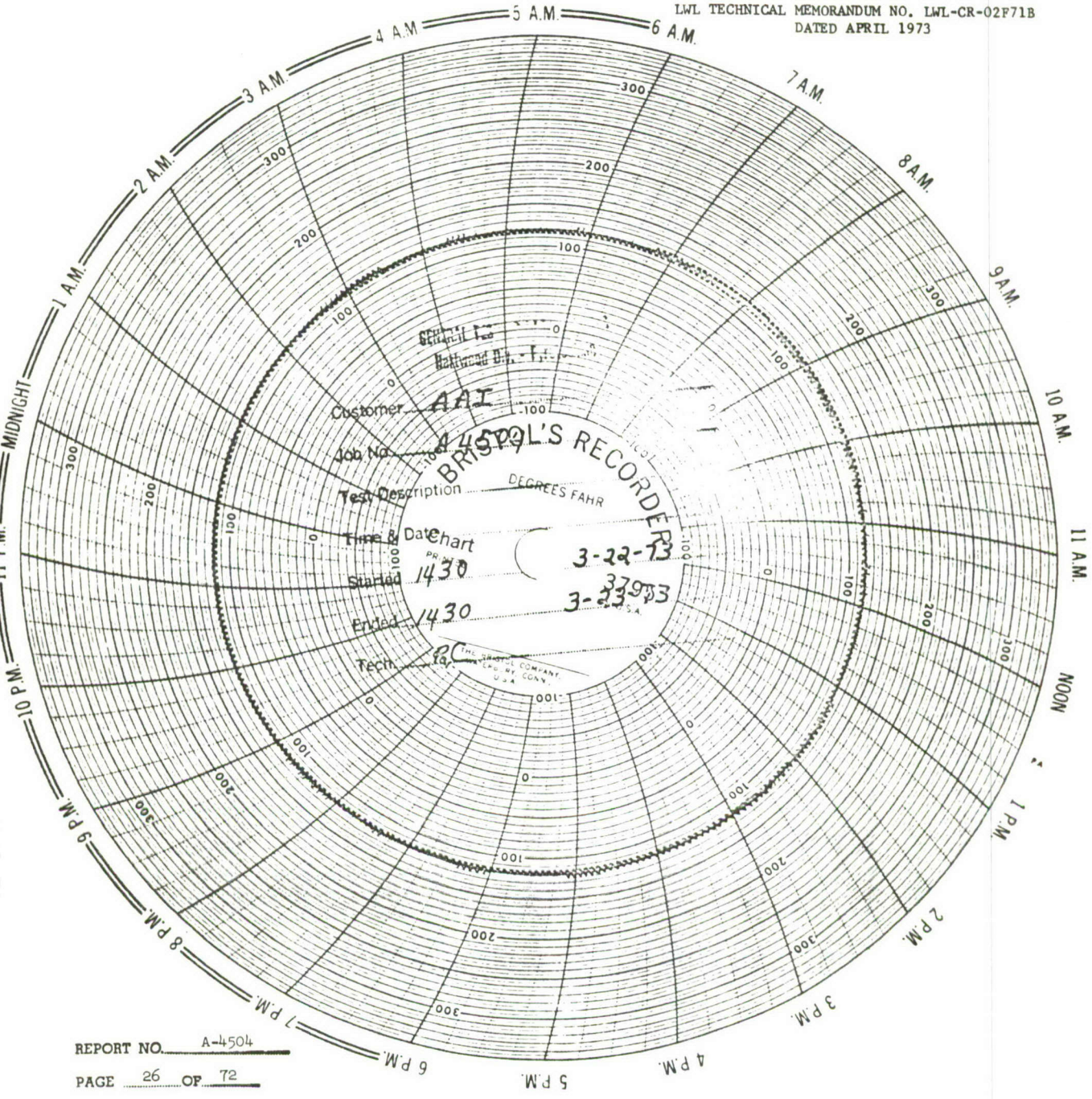
REPORT NO. A-4504

PAGE 24 OF 72



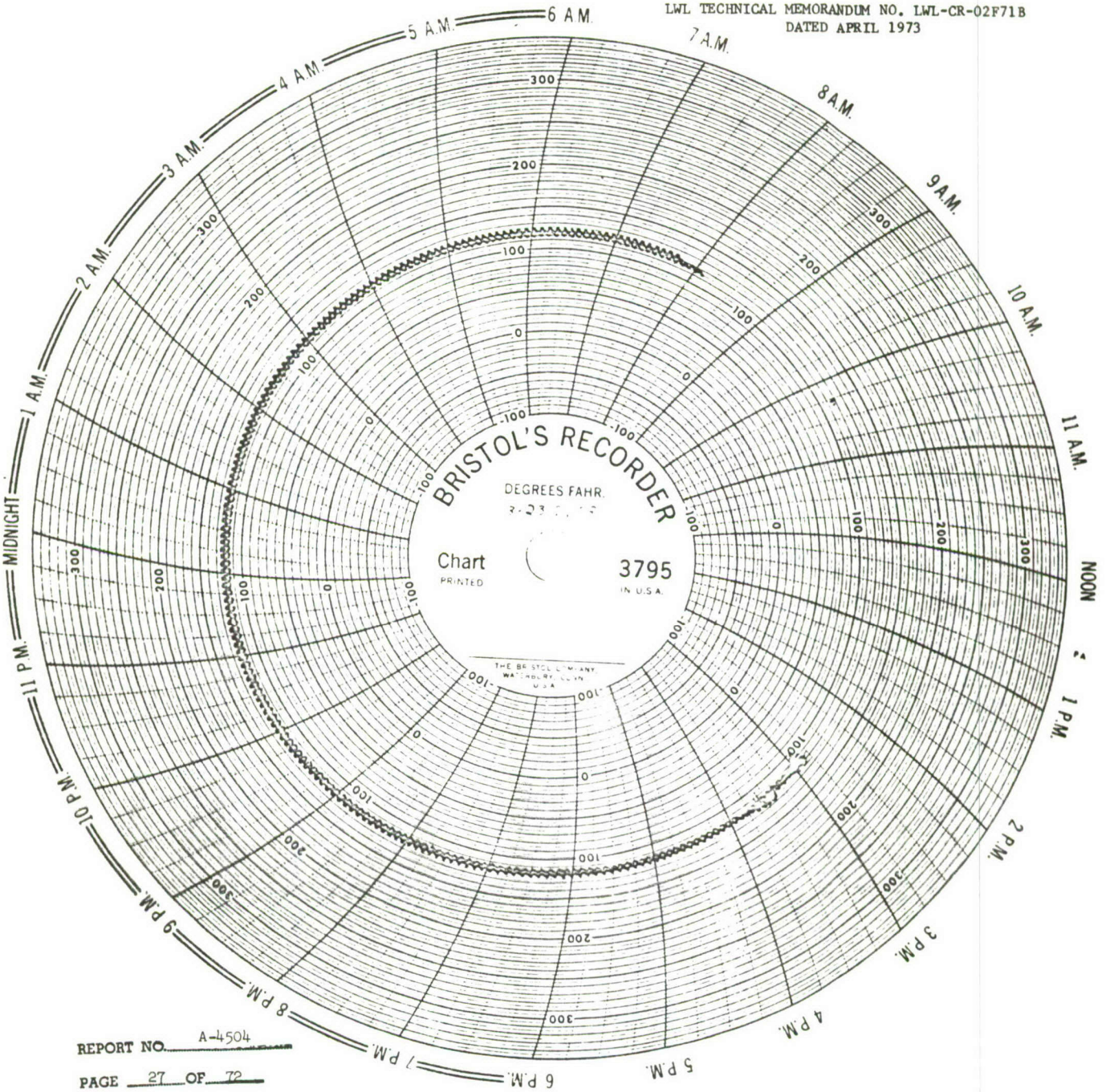
REPORT NO. A-4504

PAGE 25 OF 72



REPORT NO. A-4504

PAGE 26 OF 72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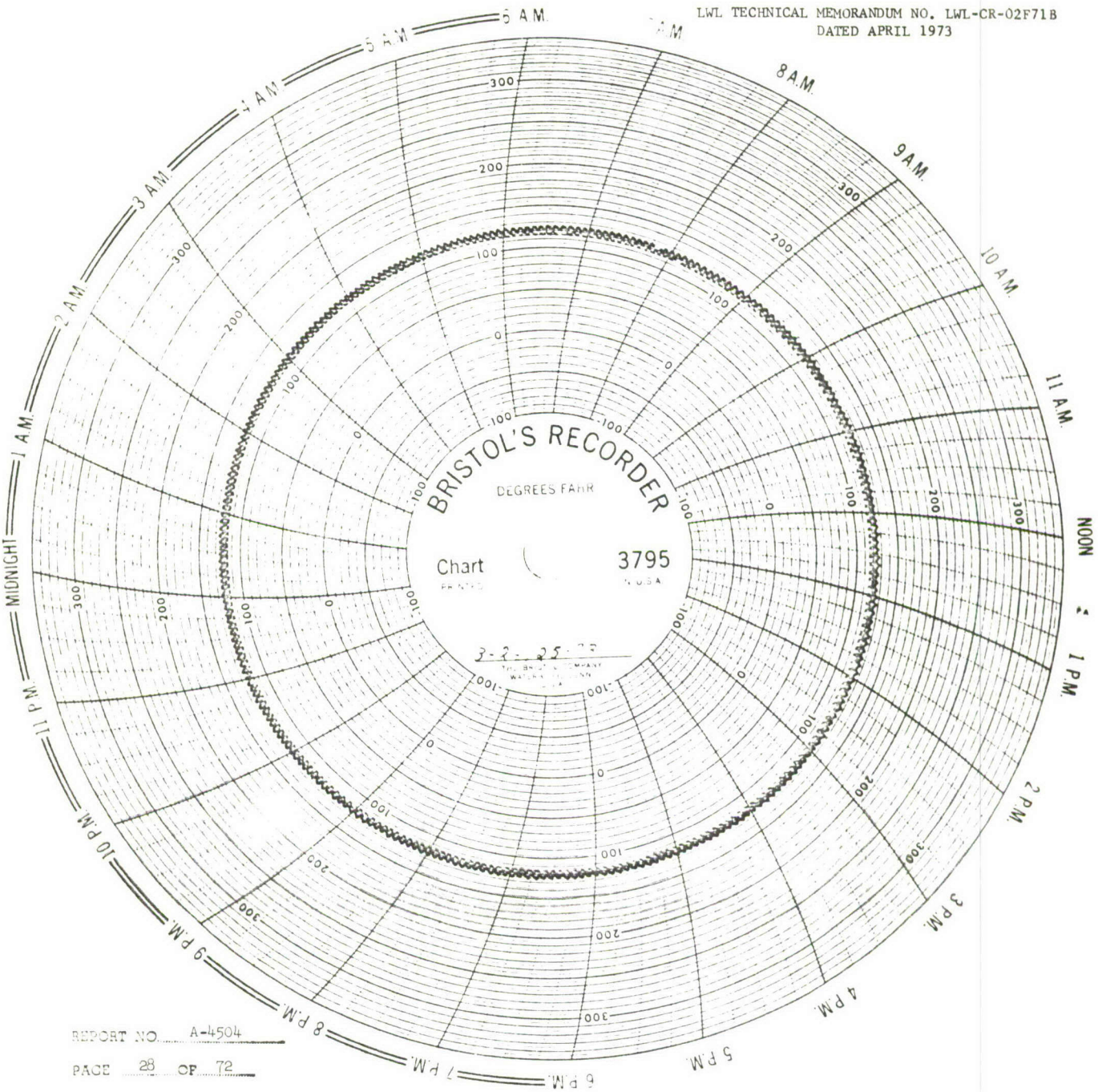
3 A.M.
2 A.M.
1 A.M.
MIDNIGHT
11 P.M.
10 P.M.
9 P.M.
8 P.M.
7 P.M.
6 P.M.
5 P.M.
4 P.M.
3 P.M.
2 P.M.
1 P.M.
NOON
11 A.M.
10 A.M.
9 A.M.
8 A.M.
7 A.M.
BRISTOL'S RECORDER
DEGREES FAHR.
Chart
PRINTED
3795
IN U.S.A.
THE BRISTOL COMPANY
WATERBURY, CONN.
U.S.A.


BRISTOL'S RECORDER
DEGREES FAHR
Chart
3795
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4 A.M.
5 A.M.
6 A.M.
7 A.M.
8 A.M.
9 A.M.
10 A.M.
11 A.M.
NOON
1 P.M.
2 P.M.
3 P.M.
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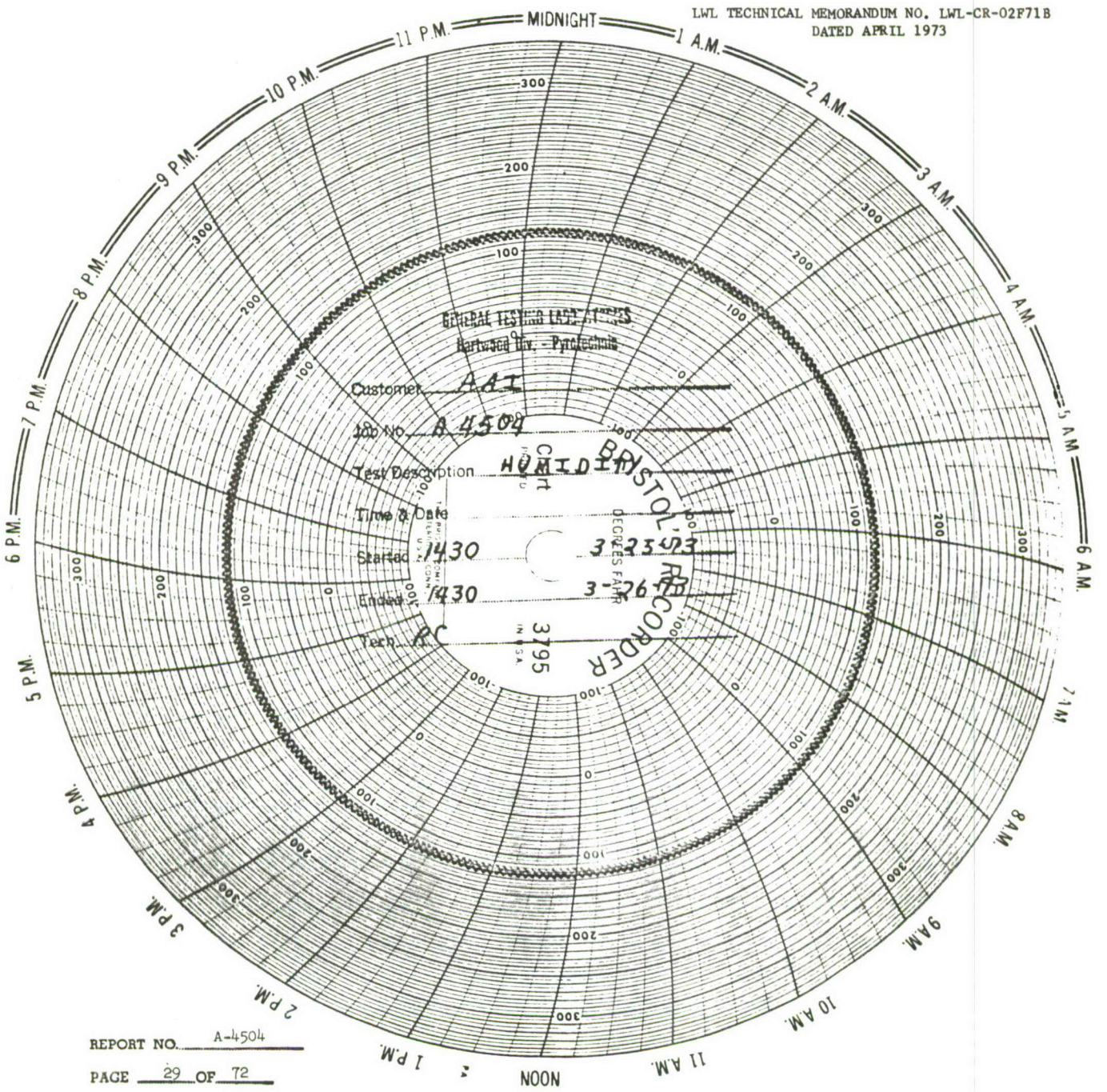

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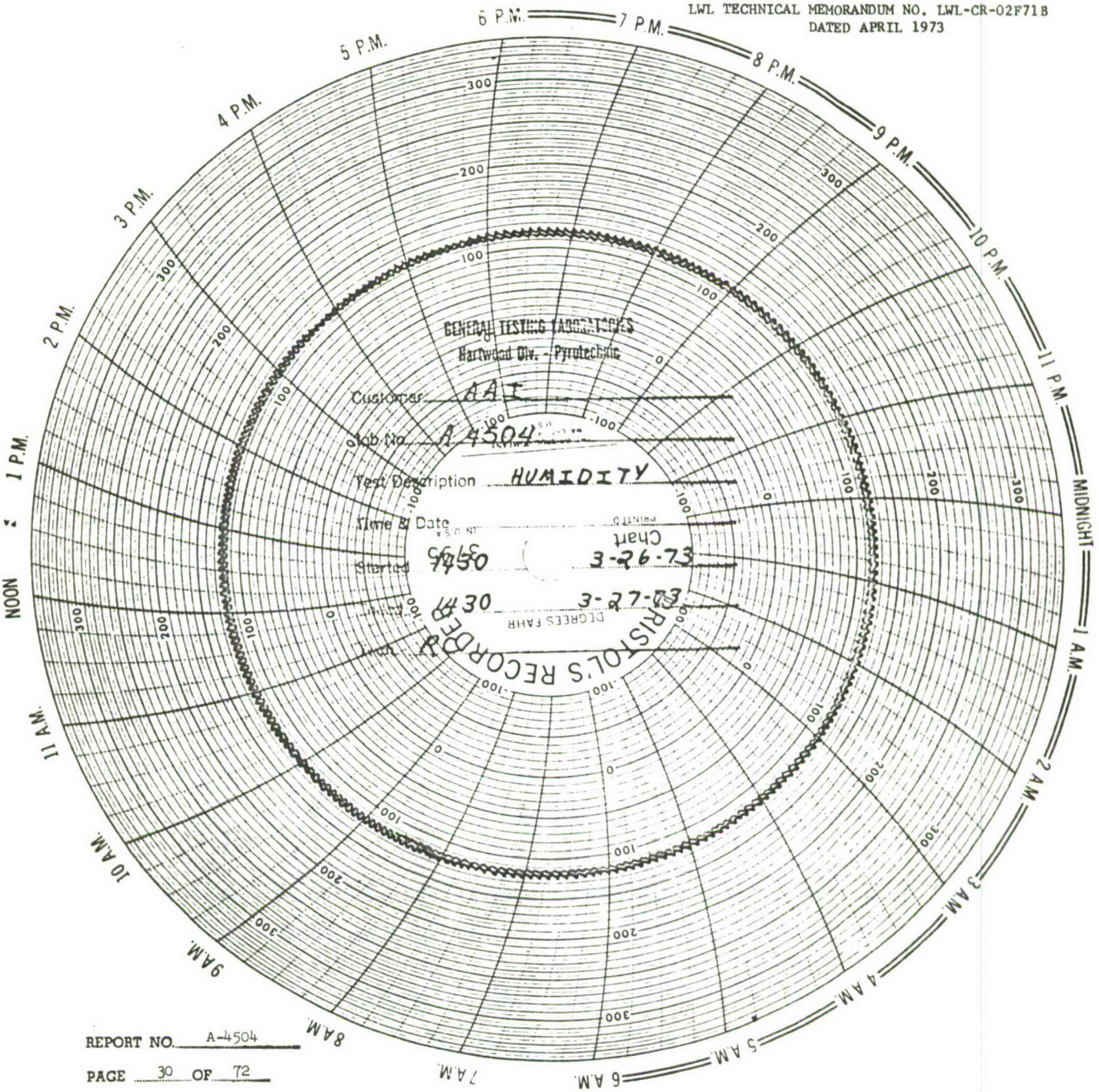
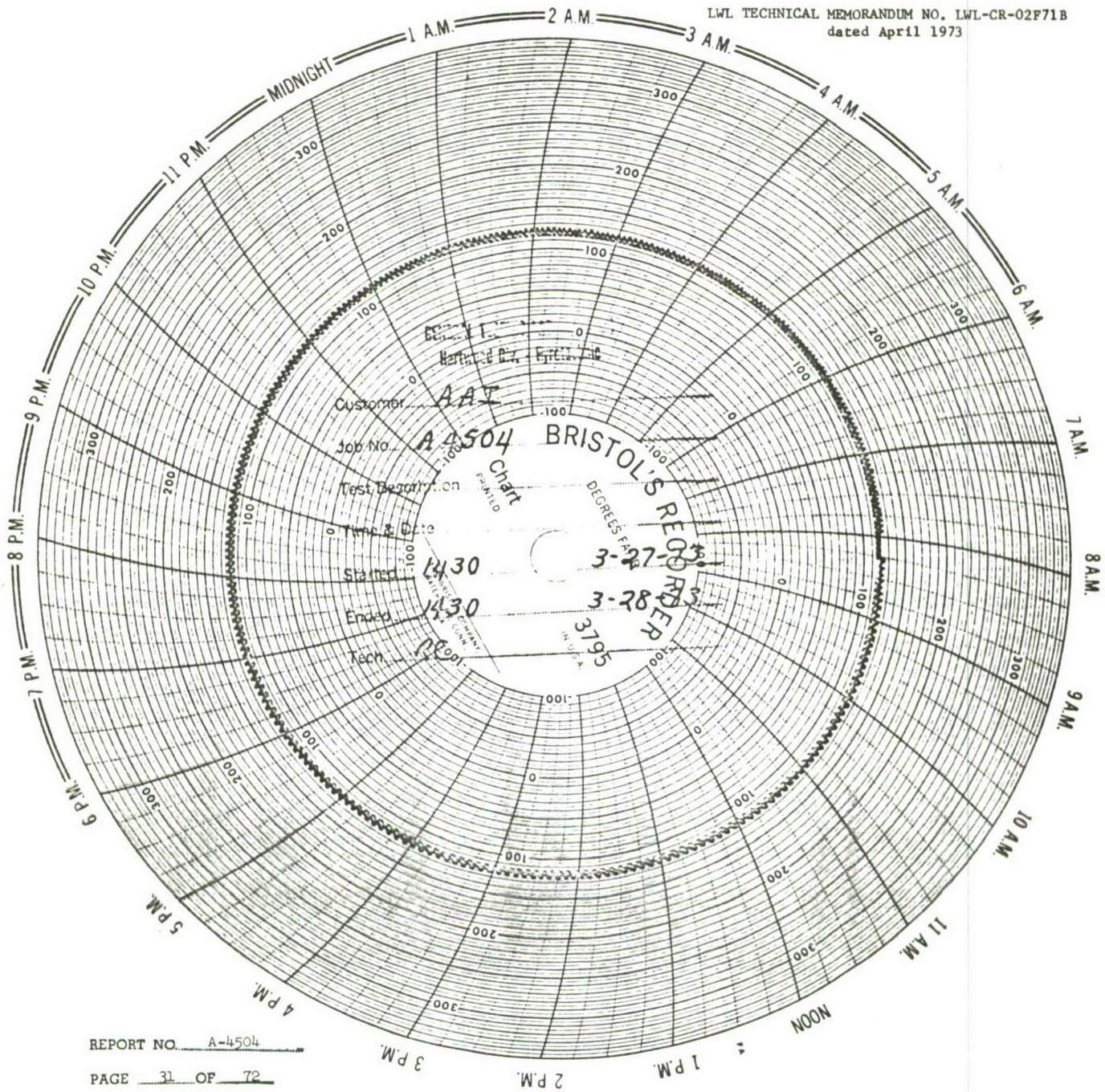


REPORT NO. A-4504

PAGE 30 OF 72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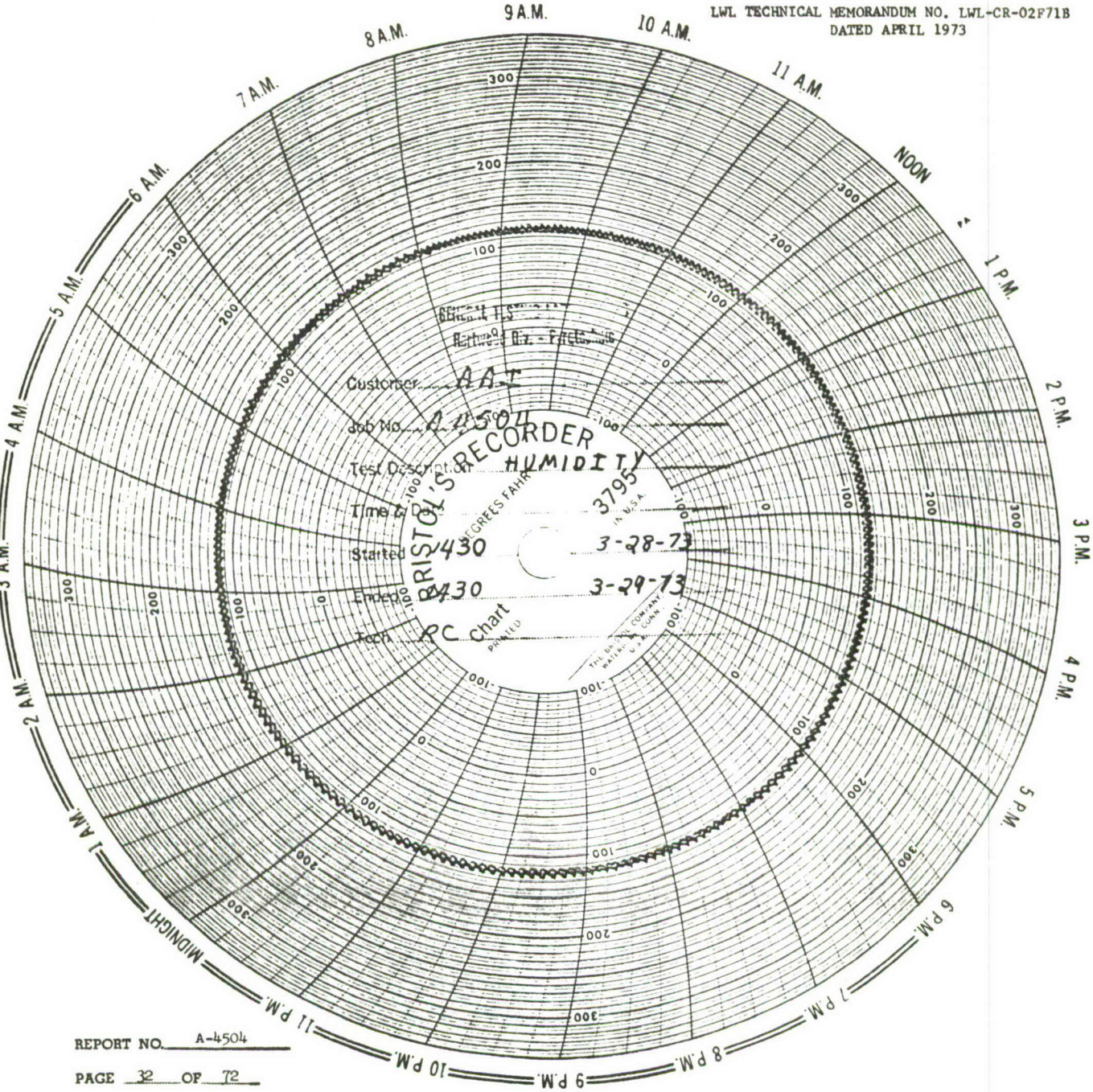
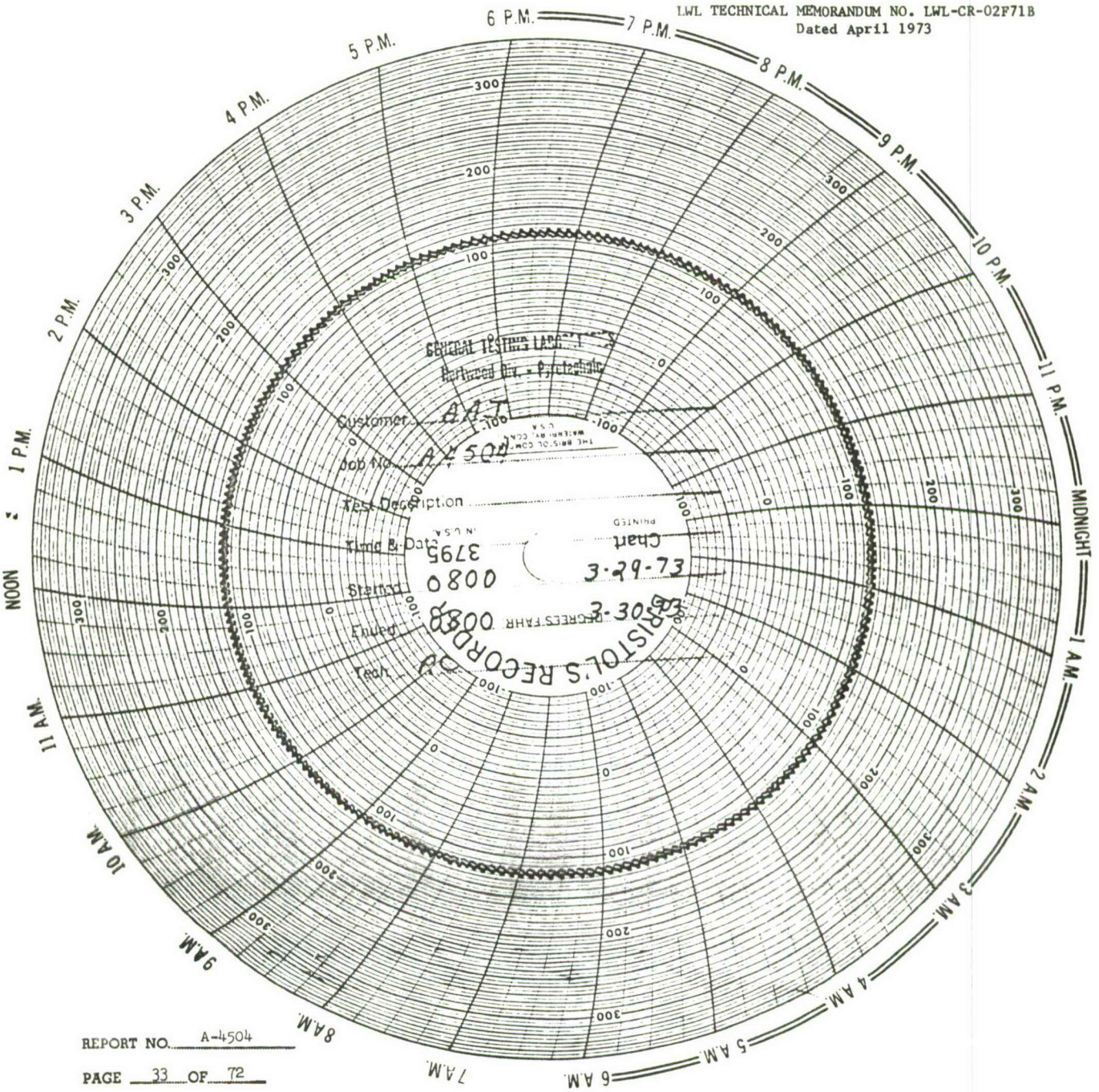
5 A.M.
6 A.M.
7 A.M.
8 A.M.
9 A.M.
10 A.M.
11 A.M.
NOON
1 P.M.
2 P.M.
3 P.M.
4 P.M.
5 P.M.
6 P.M.
7 P.M.
8 P.M.
9 P.M.
10 P.M.
11 P.M.
Customer AAT
Job No. A 4504
Test Description
Time & Date
Started 1430
Ended 1430
Tech
BRISTOL'S RECORDER
Chart
DEGREES FAHR
3-27-73
3-28
3795



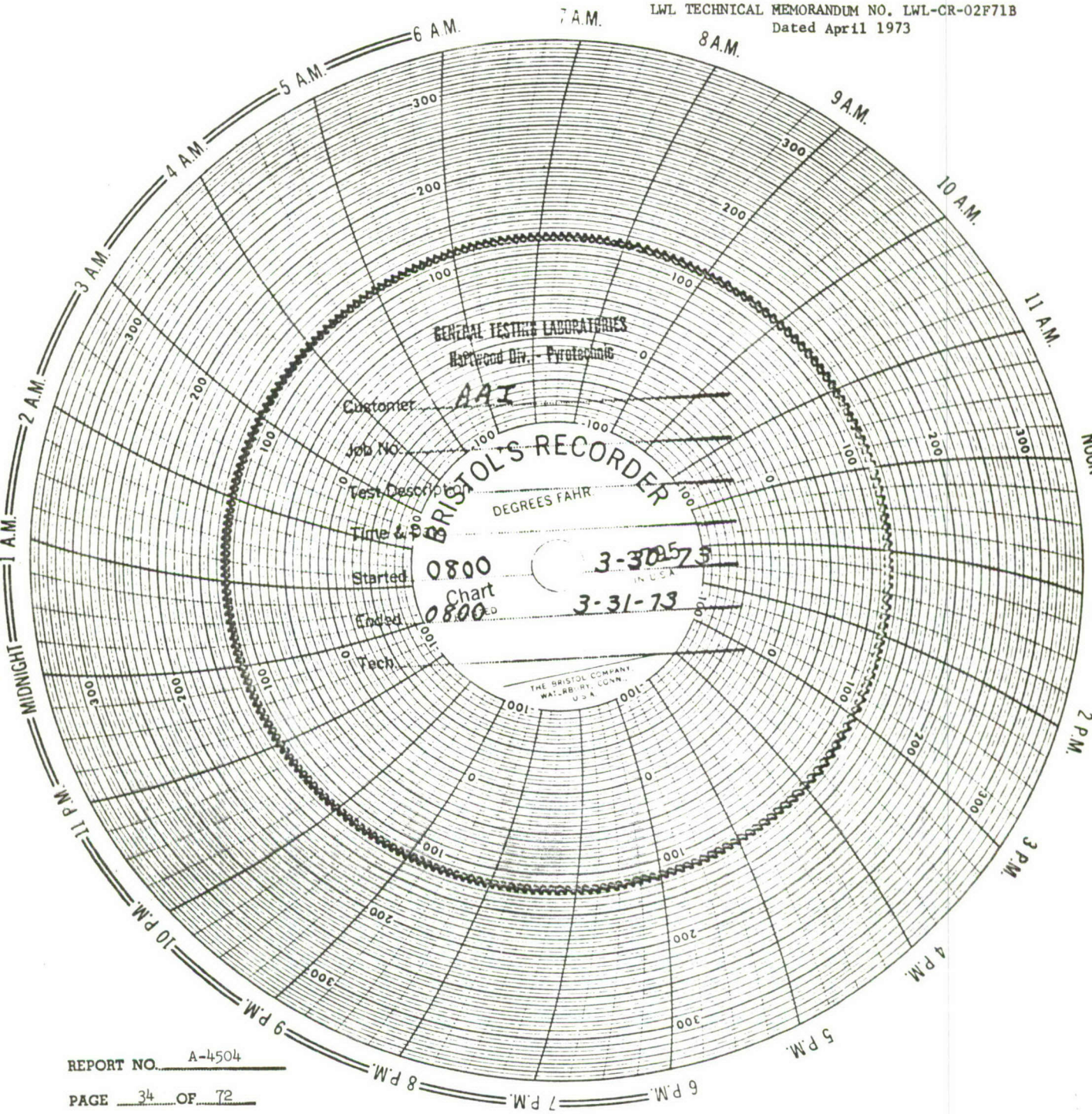
REPORT NO. A-4504

PAGE 32 OF 72



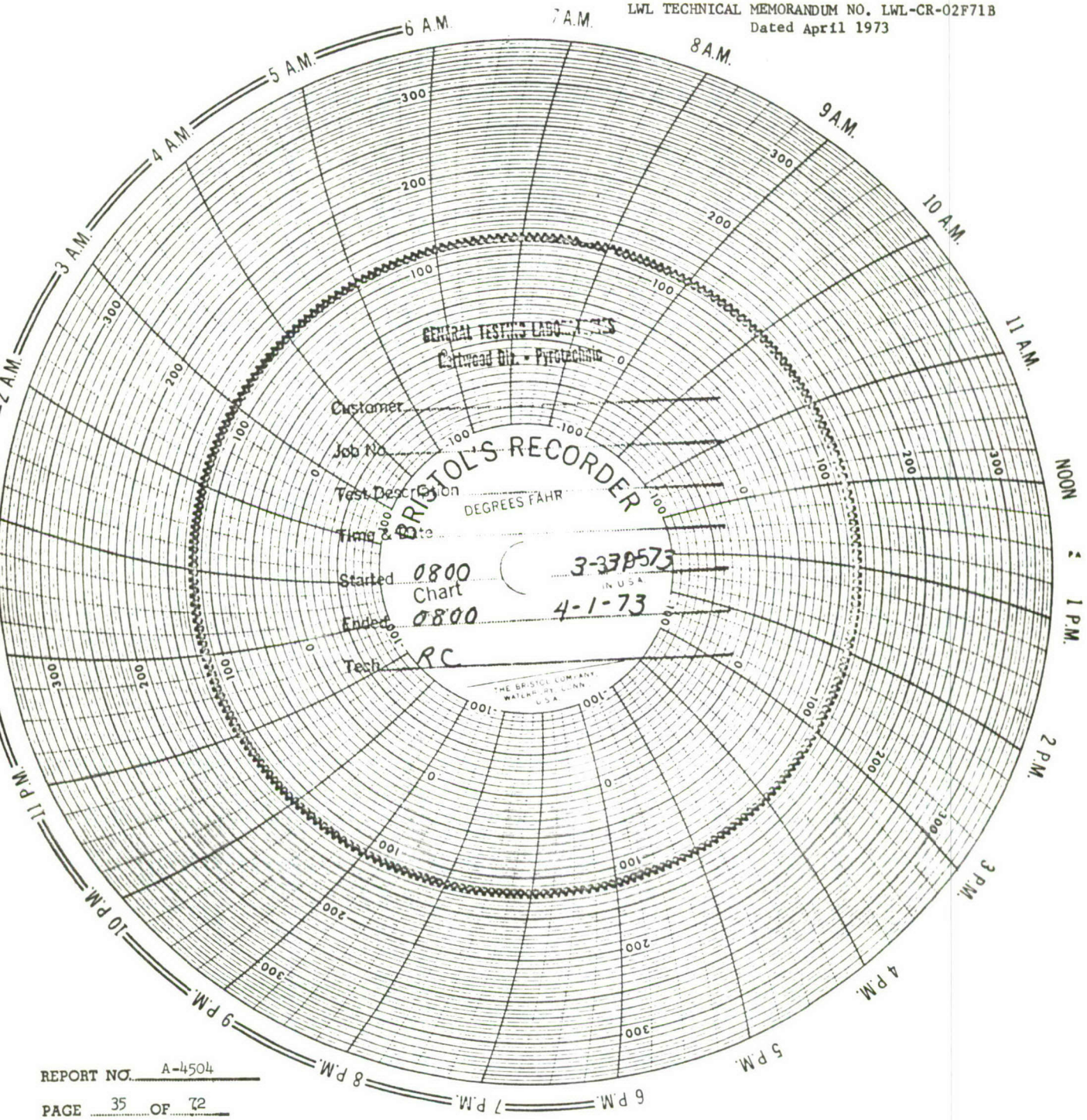
REPORT NO. A-4504

PAGE 33 OF 72



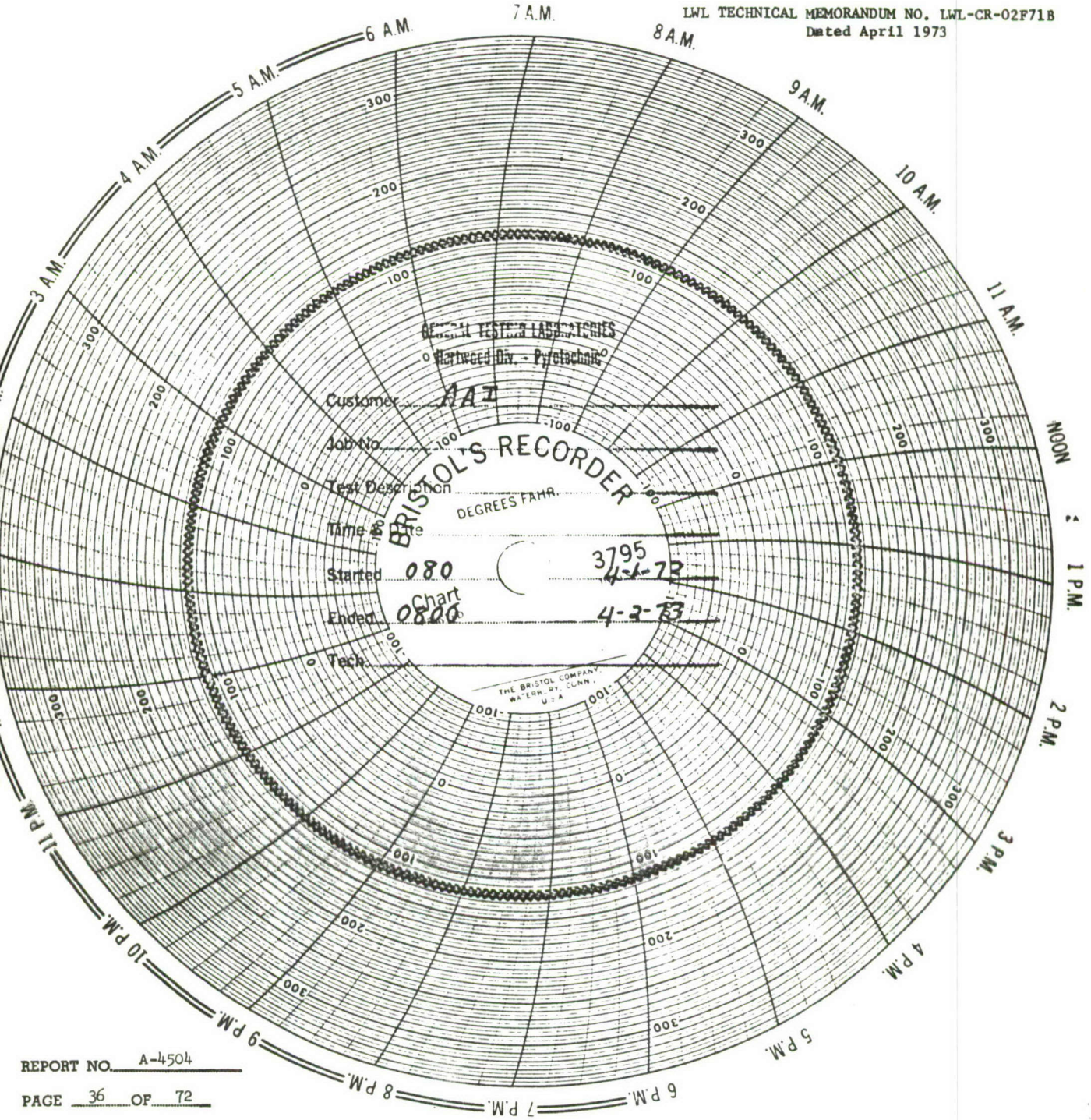
REPORT NO. A-4504

PAGE 34 OF 72



REPORT NO. A-4504

PAGE 35 OF 72



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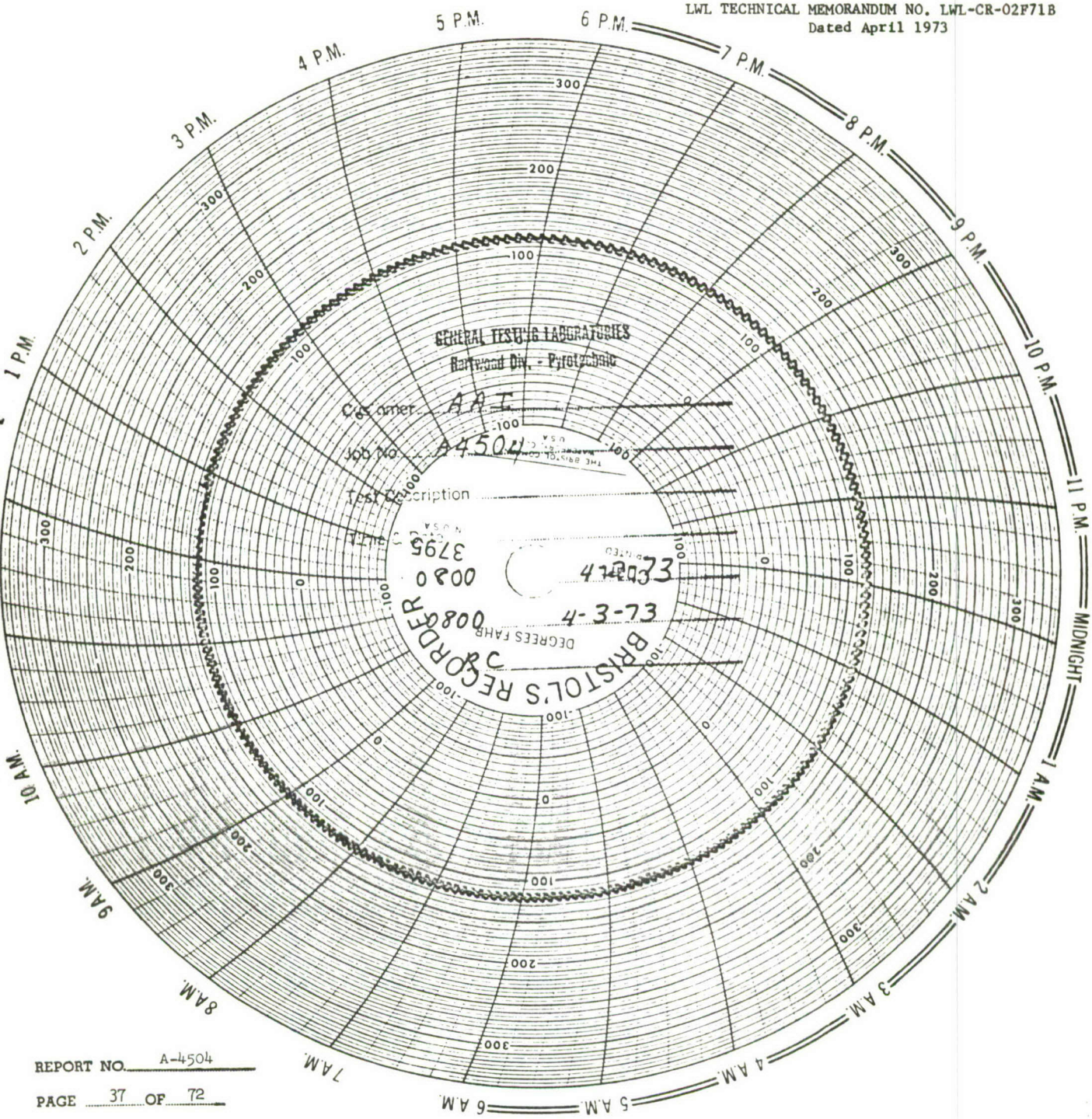

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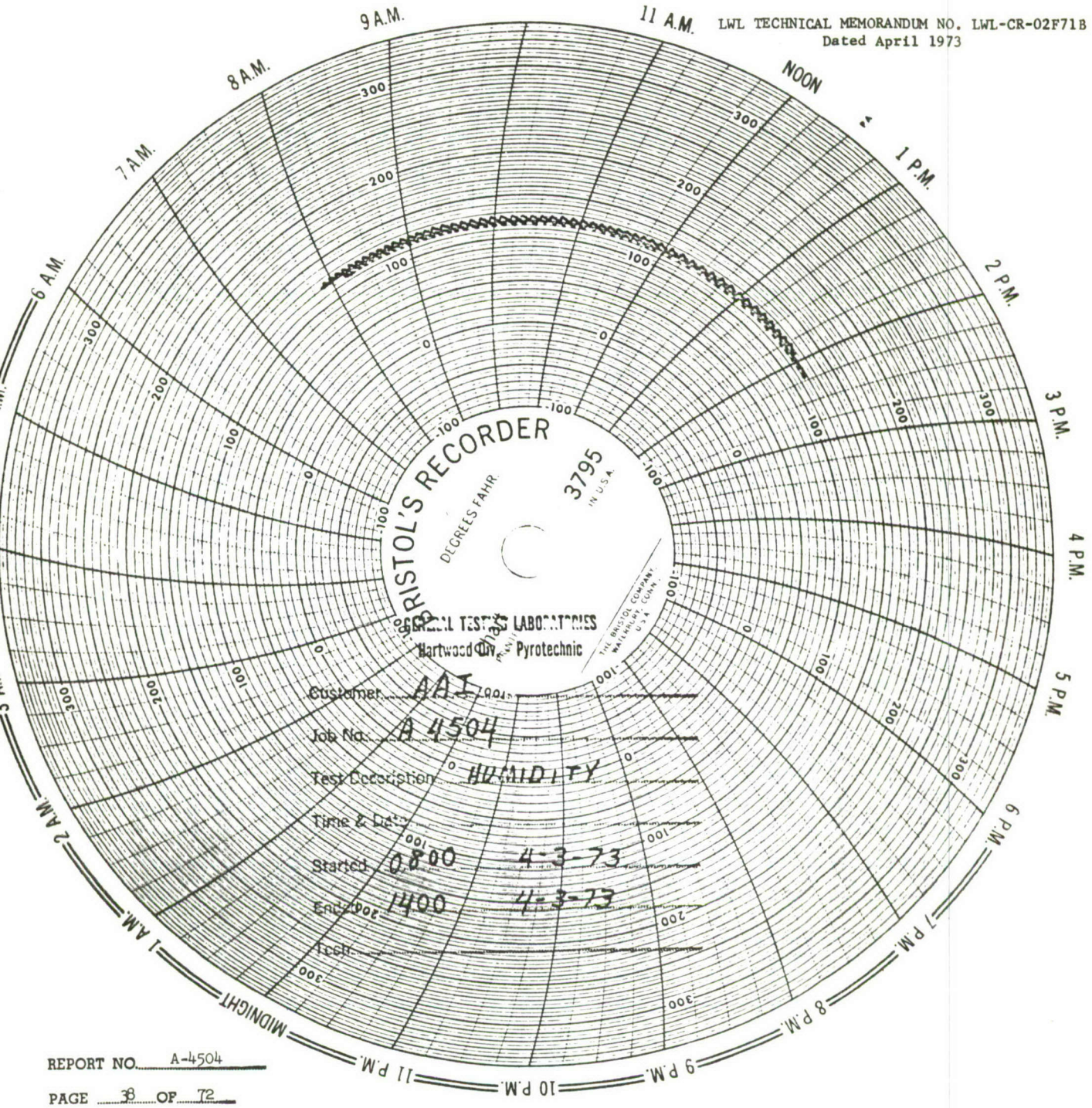
PAGE 37 OF 72



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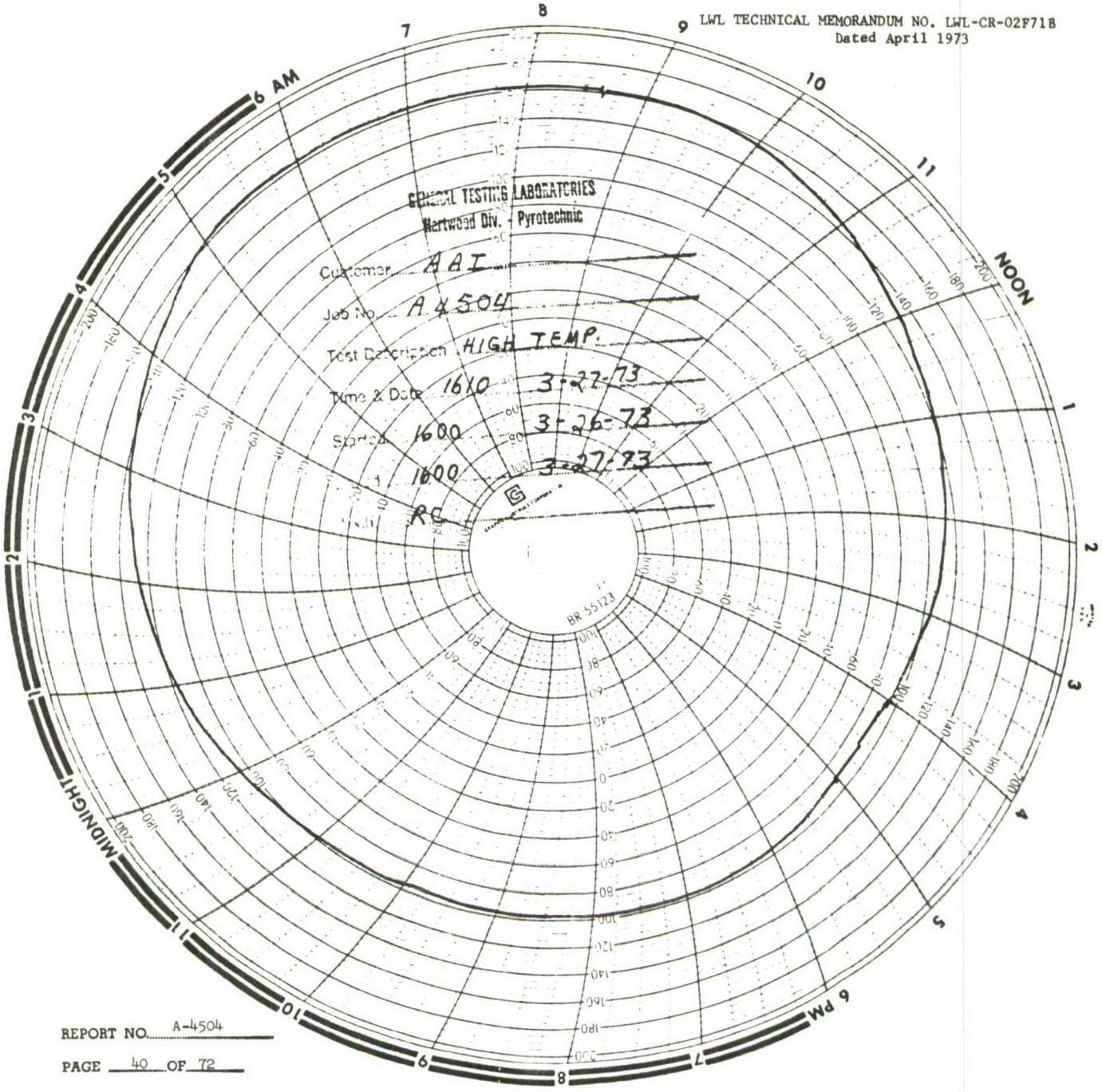
HIGH TEMPERATURE



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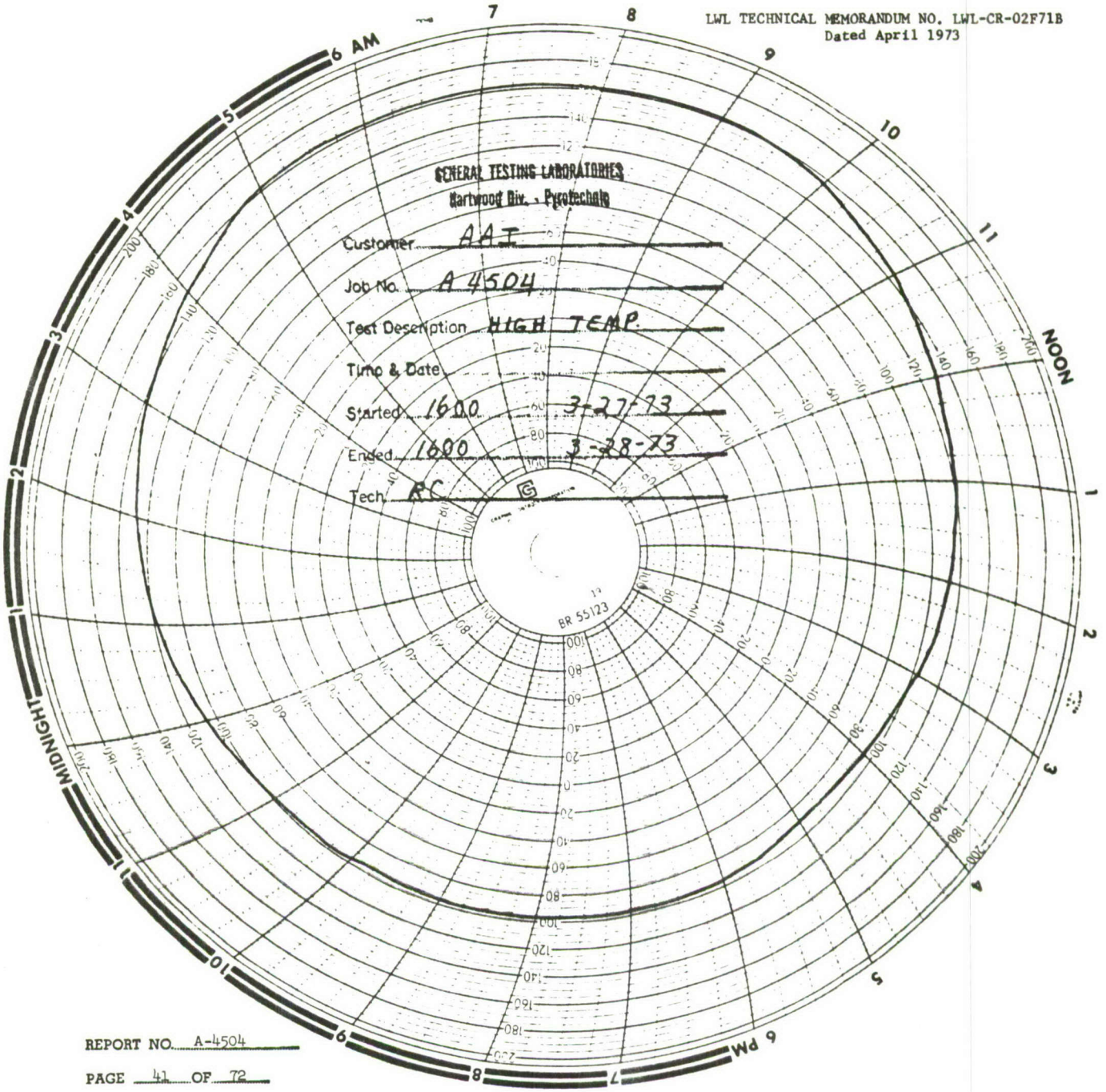
PAGE 40 OF 72



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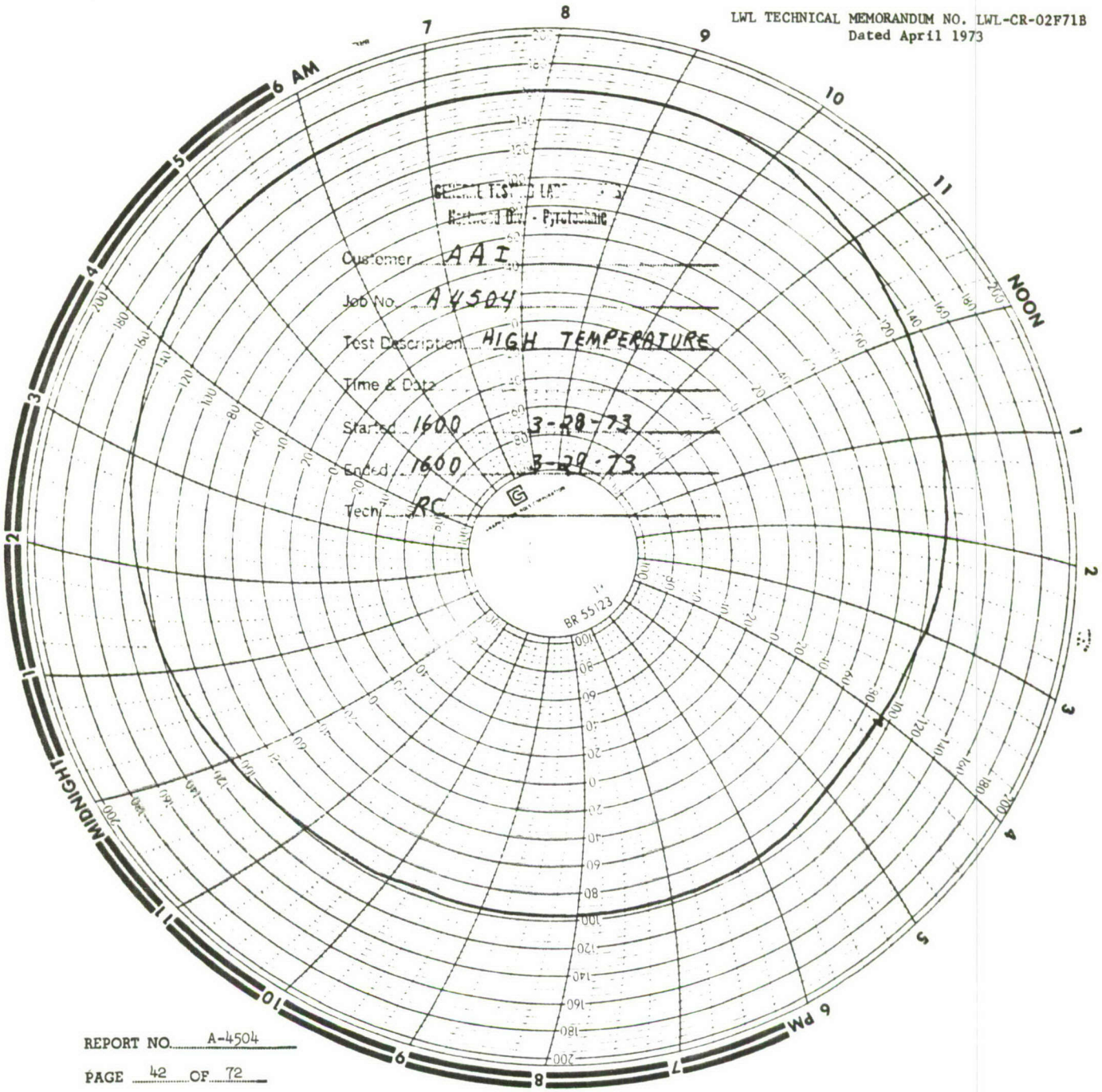
PAGE 41 OF 72



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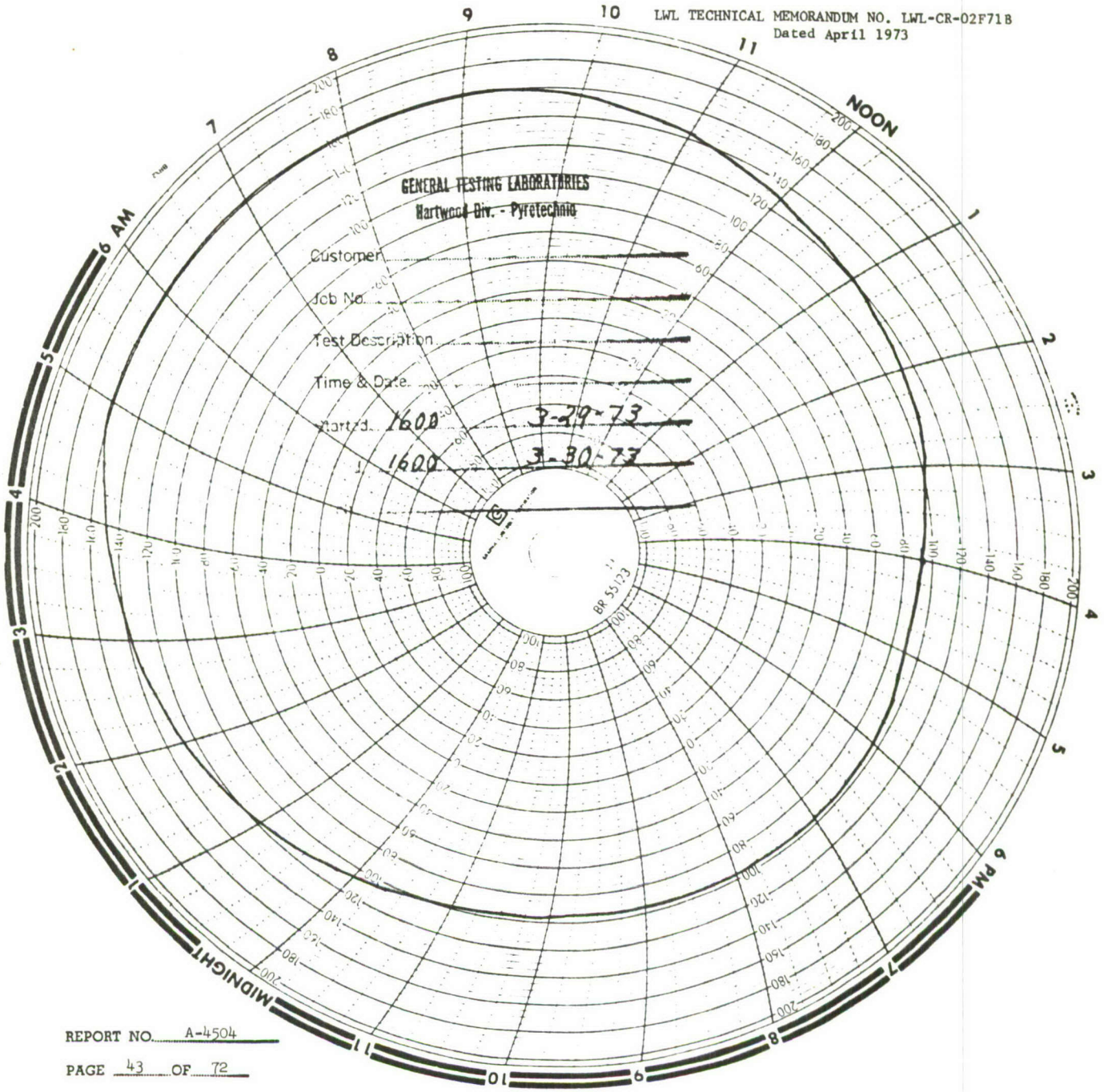
PAGE 42 OF 72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Hartwood Div. - Pyrotechnic
Customer
Job No.
Test Description
Time & Date
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1600 3-30-73
BR 55123
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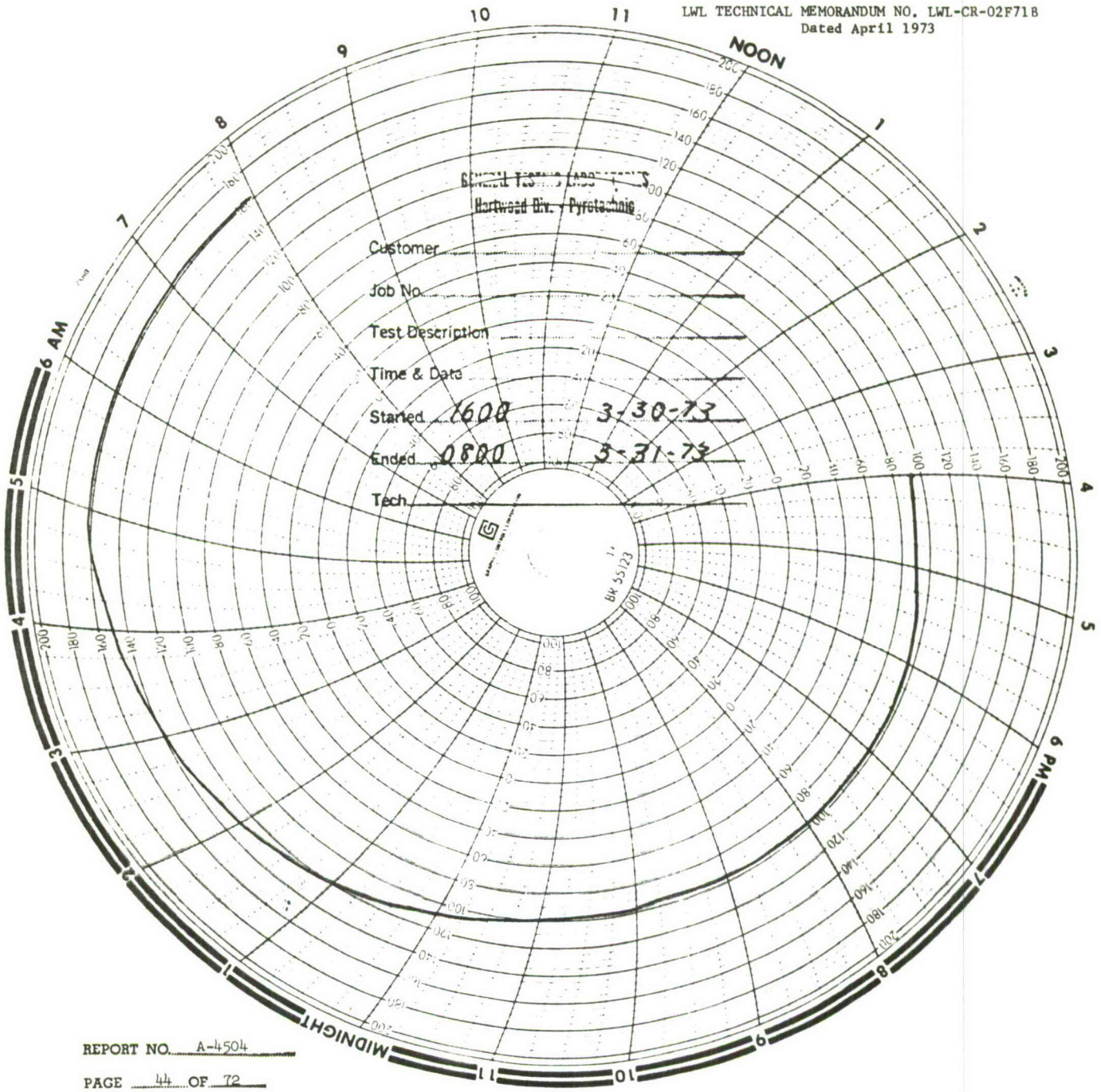
MIDNIGHT
6 AM
6 PM



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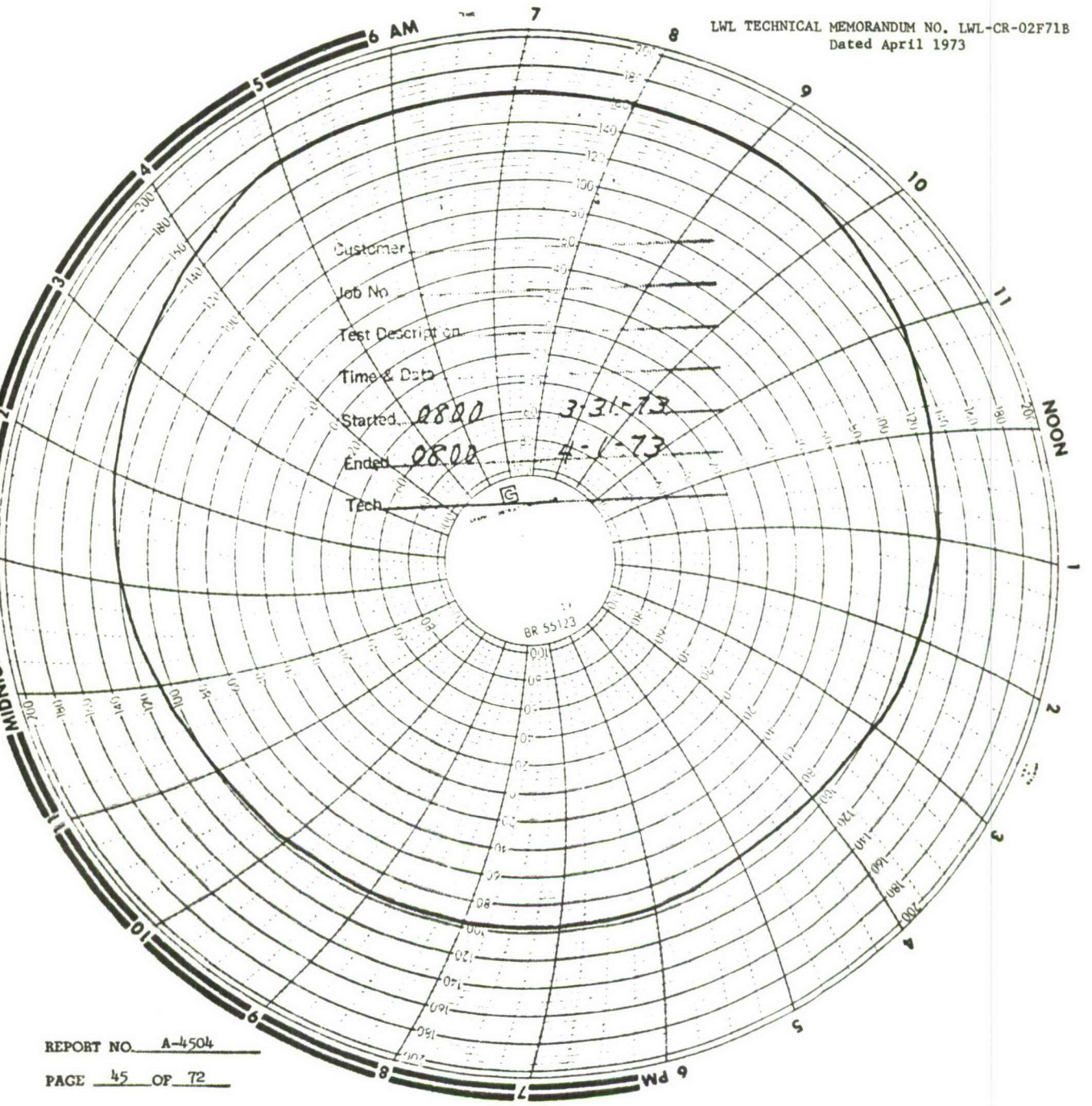
PAGE 44 OF 72


6 AM
7
8
9
10
11
NOON
1
2
3
4
5
6 PM
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8
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MIDNIGHT
Customer
Job No
Test Description
Time & Date
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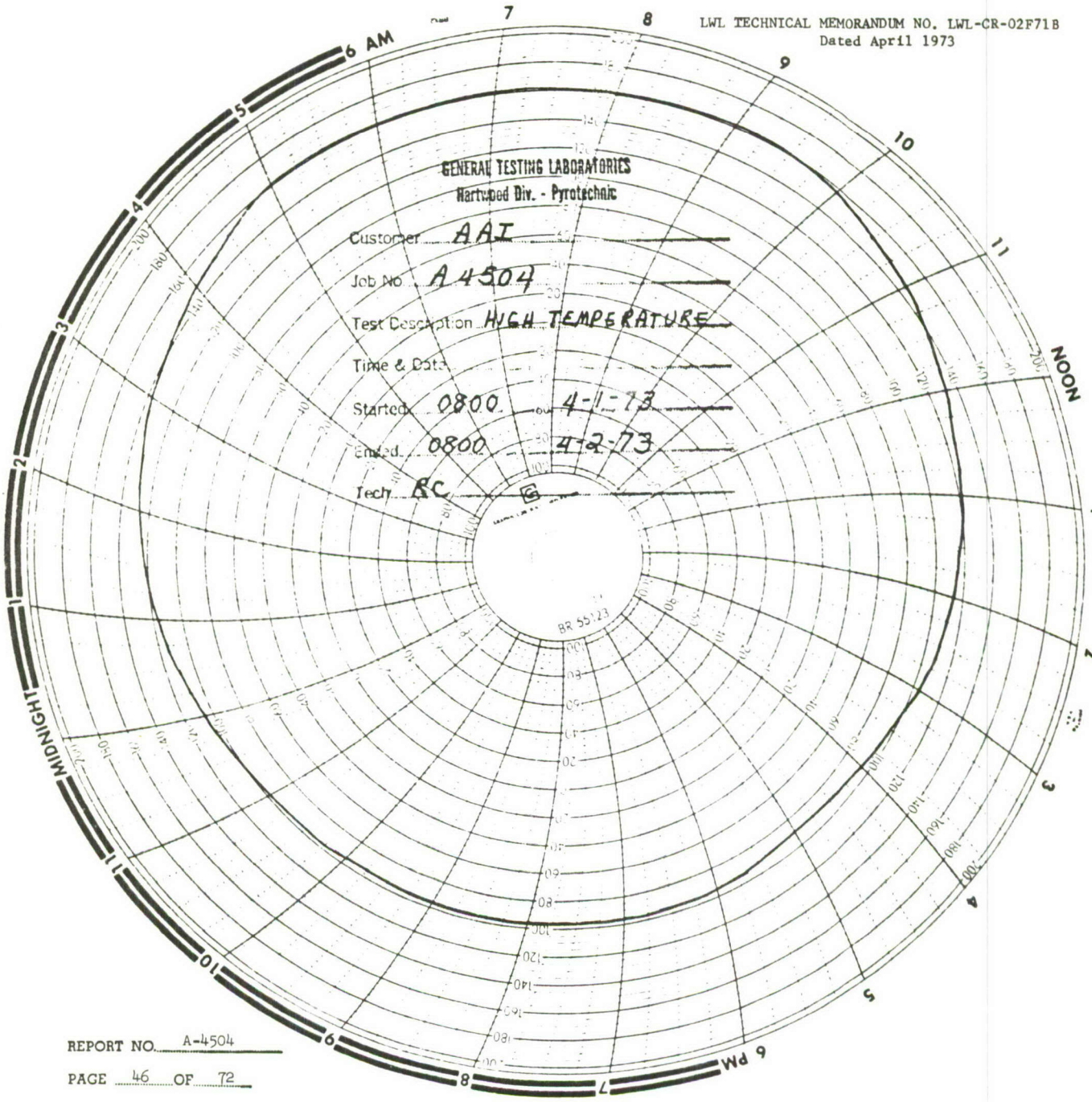
Ended 0800 4-1-73
Tech
BR 55123



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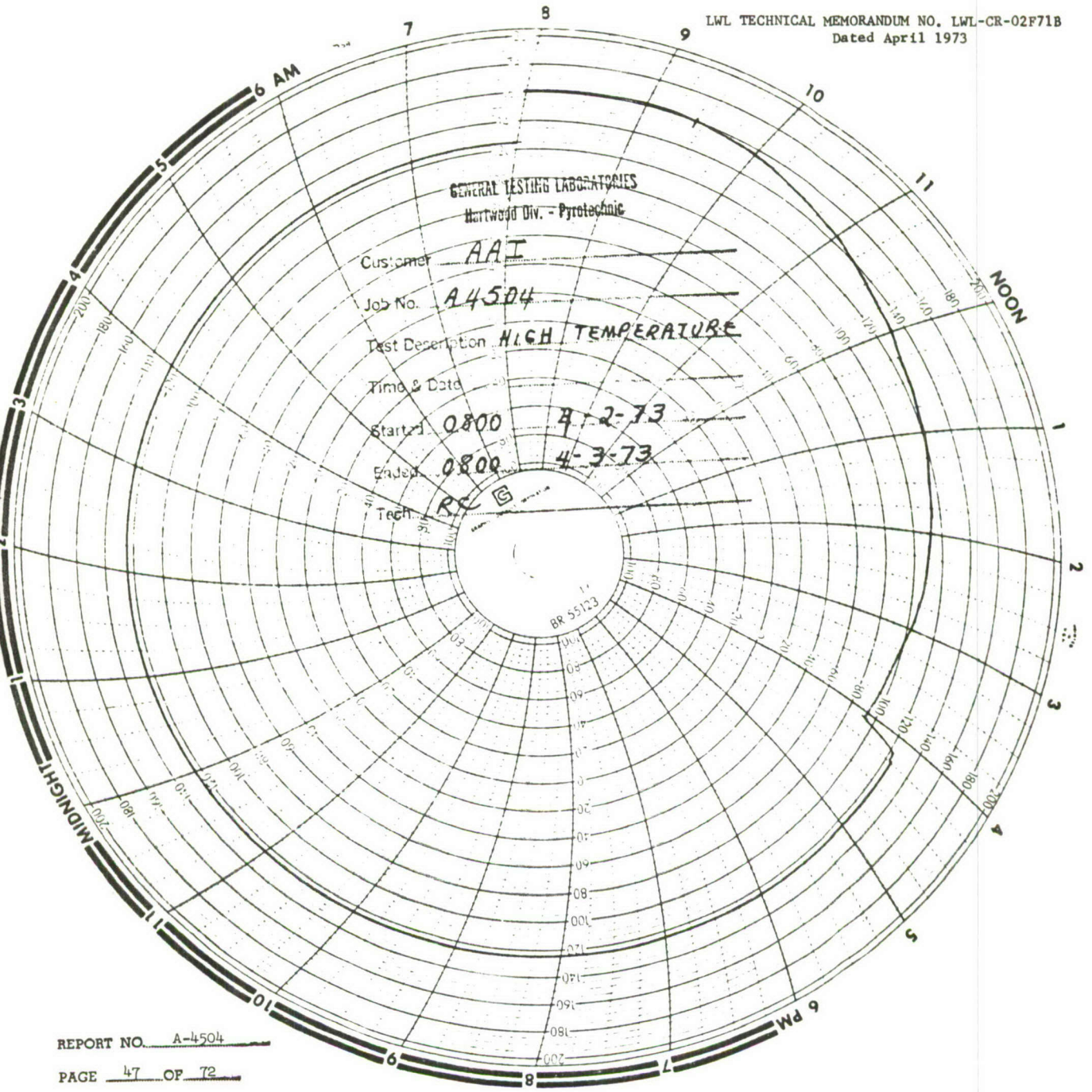
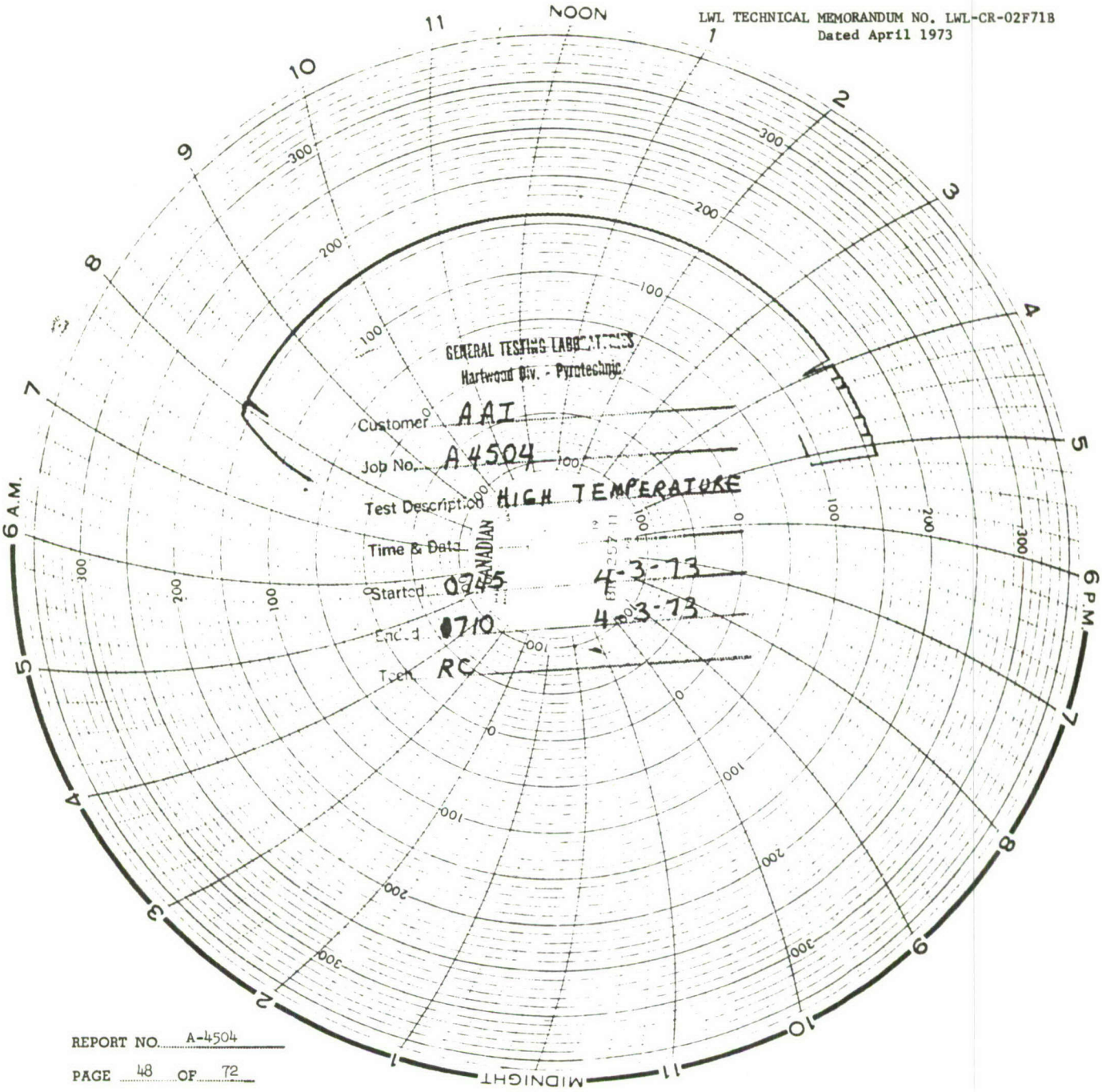
PAGE 46 OF 72



REPORT NO. A-4504

PAGE 47 OF 72


NOON
MIDNIGHT
6 A.M.
6 P.M.
CANADIAN
GENERAL TESTING LABORATORIES
Hartwood Div. - Pyrotechnic
Customer AAI
Job No. A4504
Test Description HIGH TEMPERATURE
Time & Date
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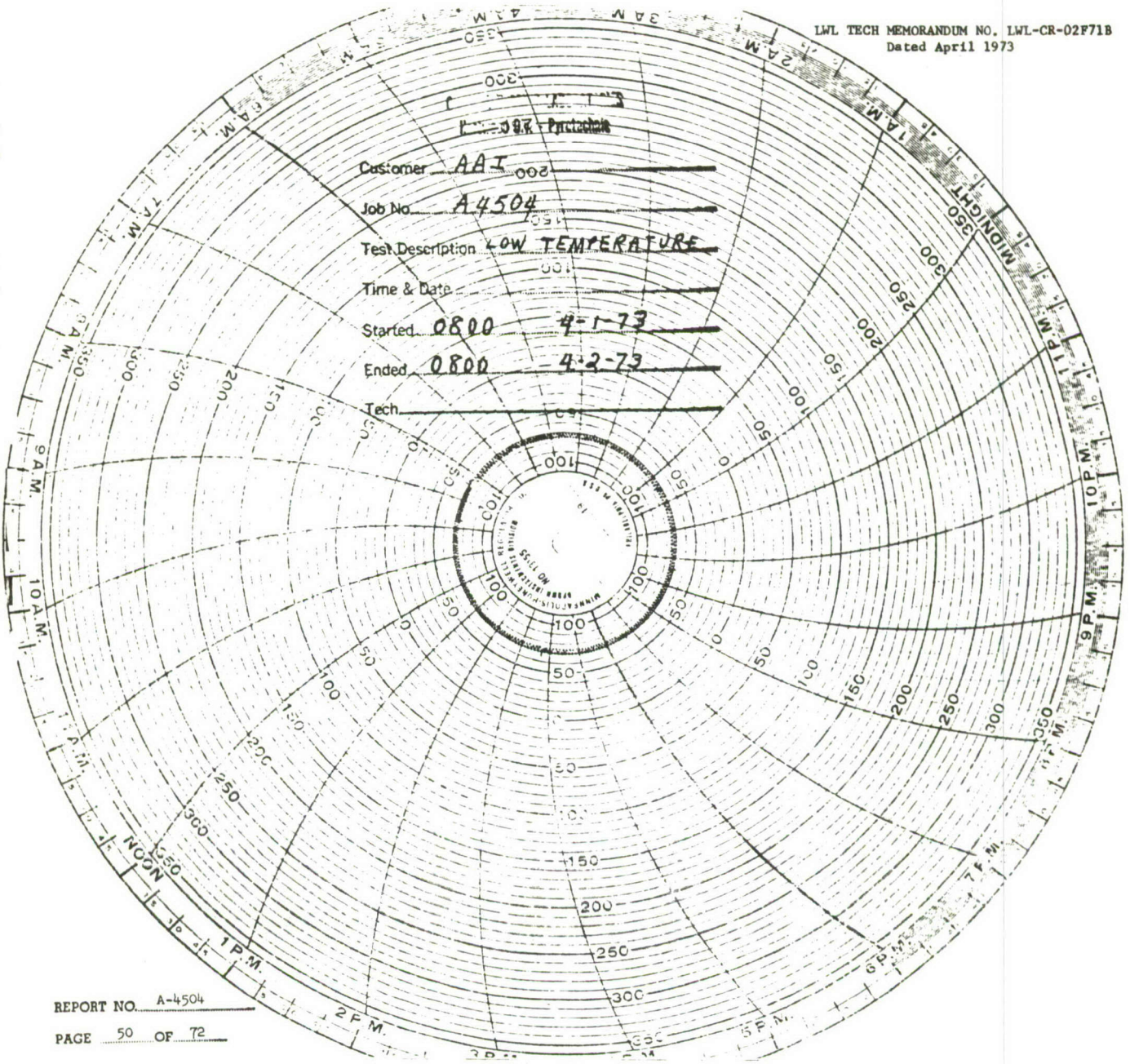
End 1710 4-3-73
Tech RC

LOW TEMPERATURE


Customer AAI
Job No. A4504
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Ended 0800 4-2-73
Tech
MIDNIGHT
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3 A.M.
4 A.M.
5 A.M.
6 A.M.
7 A.M.
8 A.M.
9 A.M.
10 A.M.
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1 P.M.
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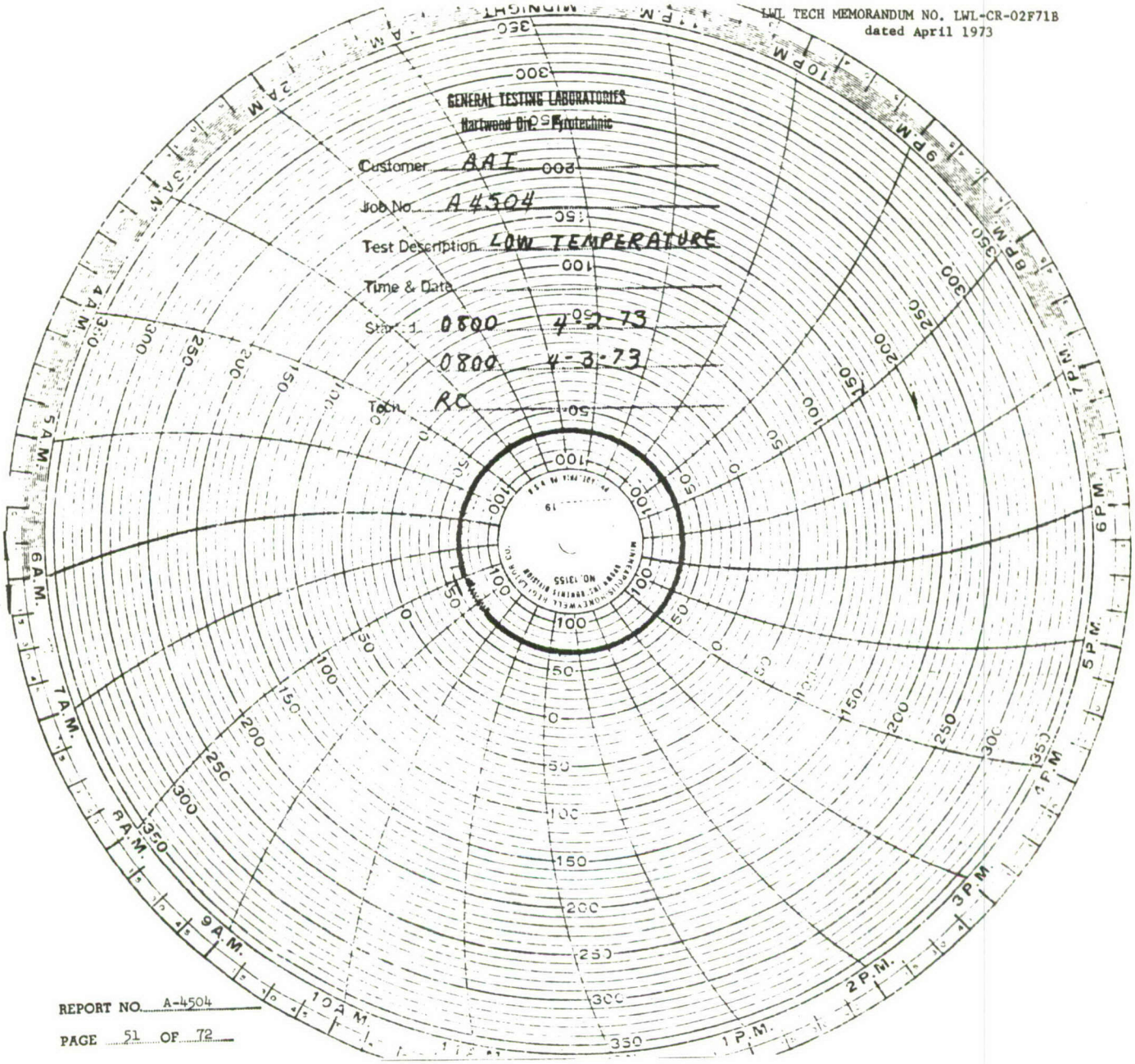
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Hartwood Div. Pyrotechnic
Customer AAI
Job No. A4504
Test Description LOW TEMPERATURE
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0800 4-3-73
Tech RC
MINNEAPOLIS-HONEYWELL REGULATOR CO.
MIDDLE DIVISION
NO. 19155
12 MIDNIGHT
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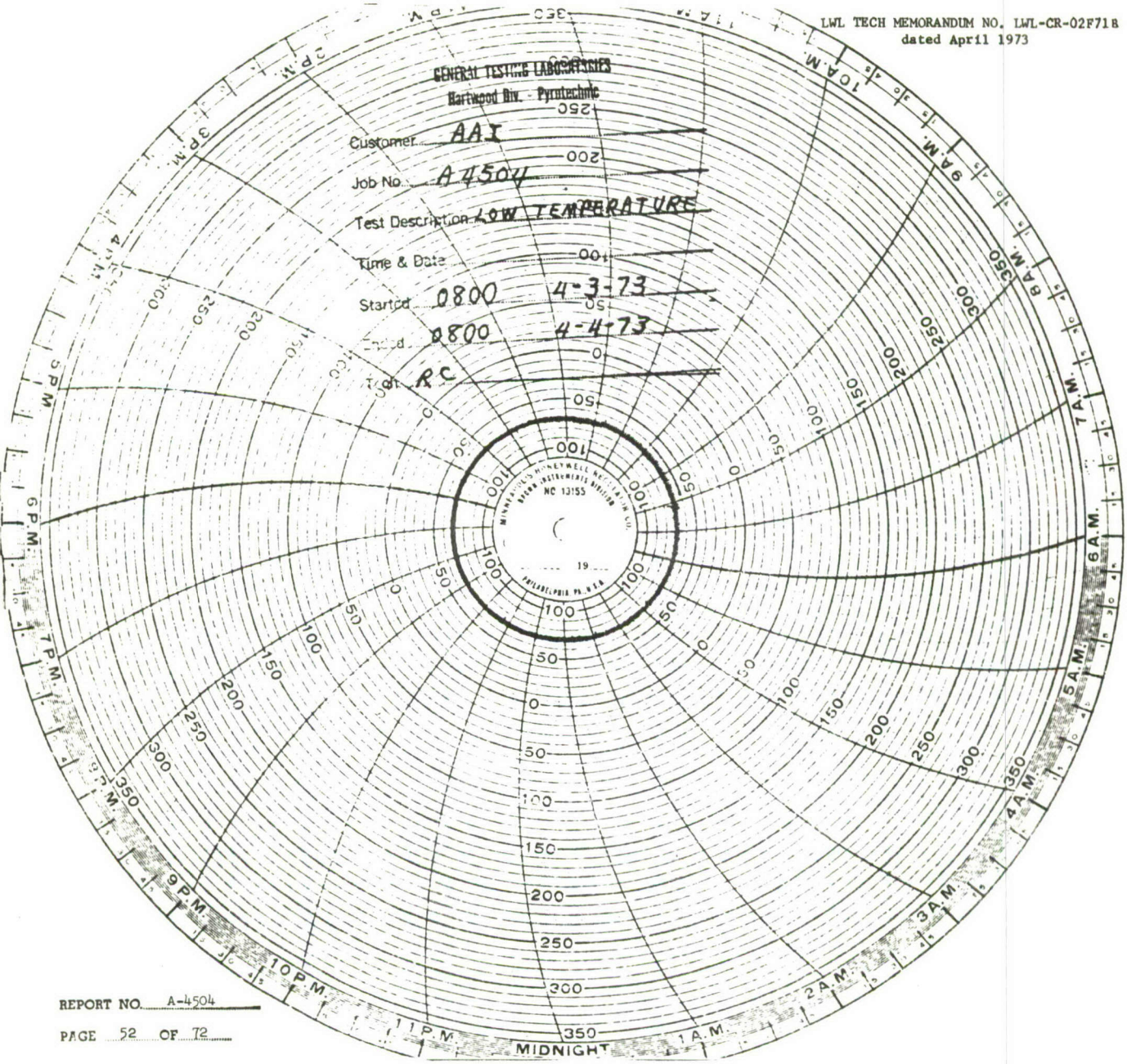
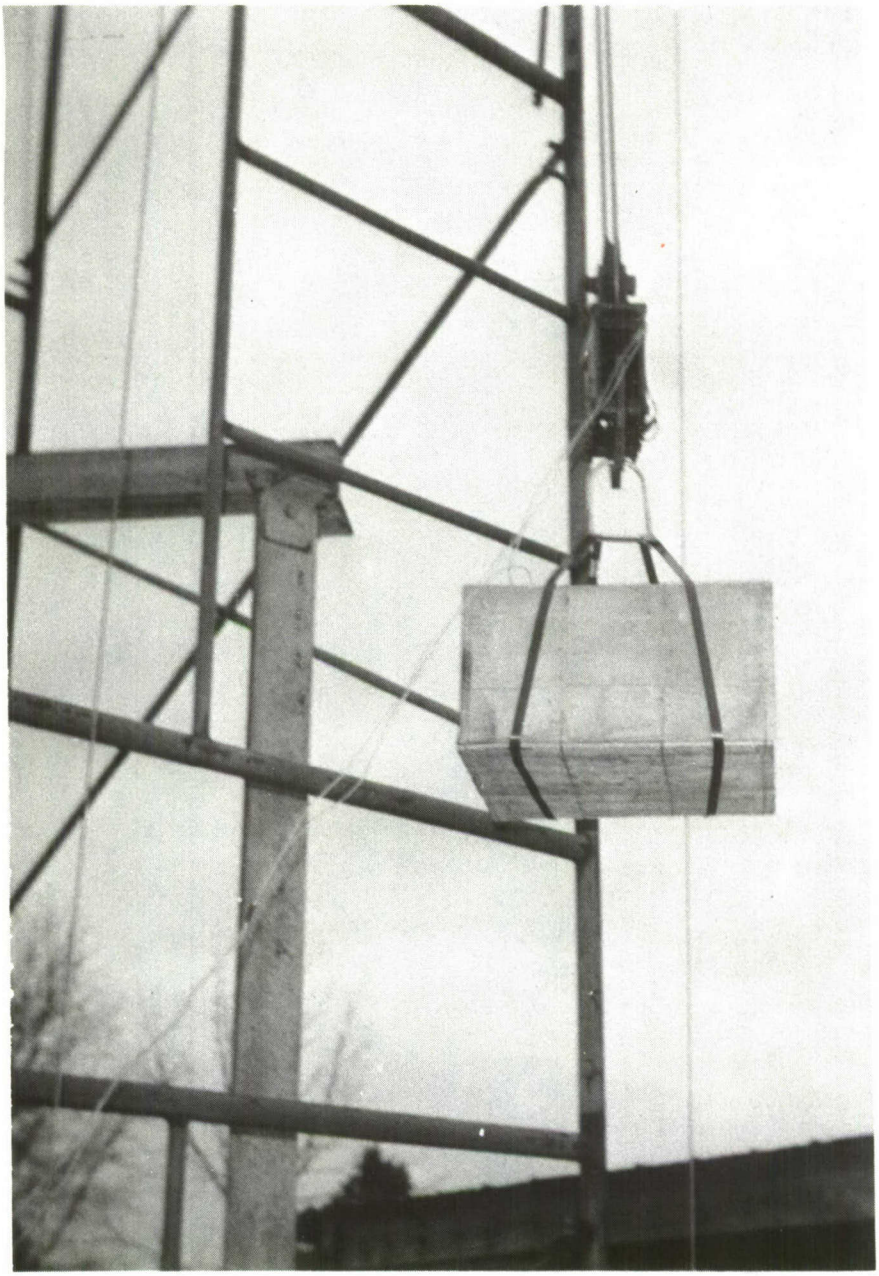
2 A.M.
3 A.M.
4 A.M.
5 A.M.
6 A.M.
7 A.M.
8 A.M.
9 A.M.
10 A.M.
11 A.M.
12 NOON
1 P.M.
2 P.M.
3 P.M.
4 P.M.
5 P.M.
6 P.M.
7 P.M.
8 P.M.
9 P.M.
10 P.M.
11 P.M.



REPORT NO. A-4504

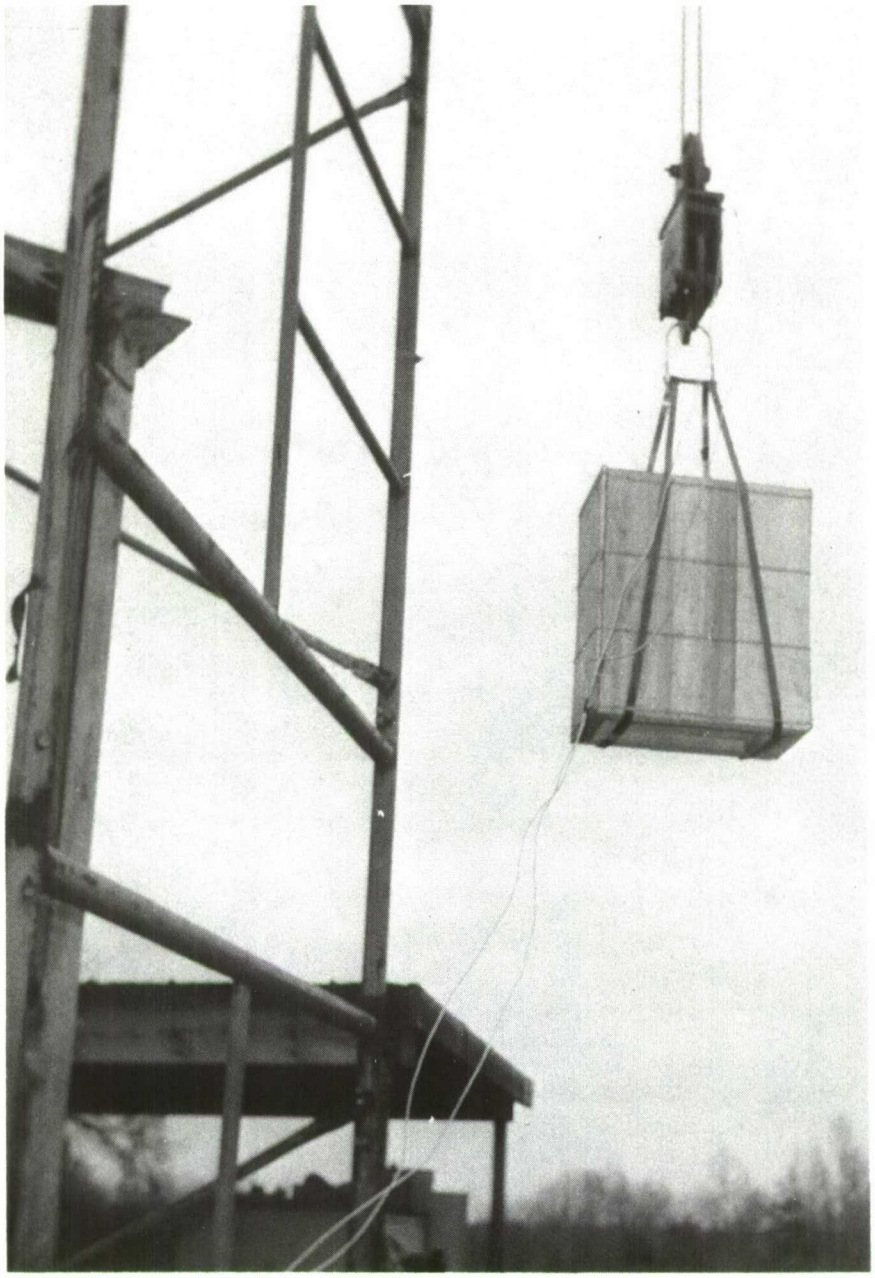
APPENDIX C

Photographs



SEVEN FOOT PACKAGED DROP

SEVEN FOOT PACKAGED DROP



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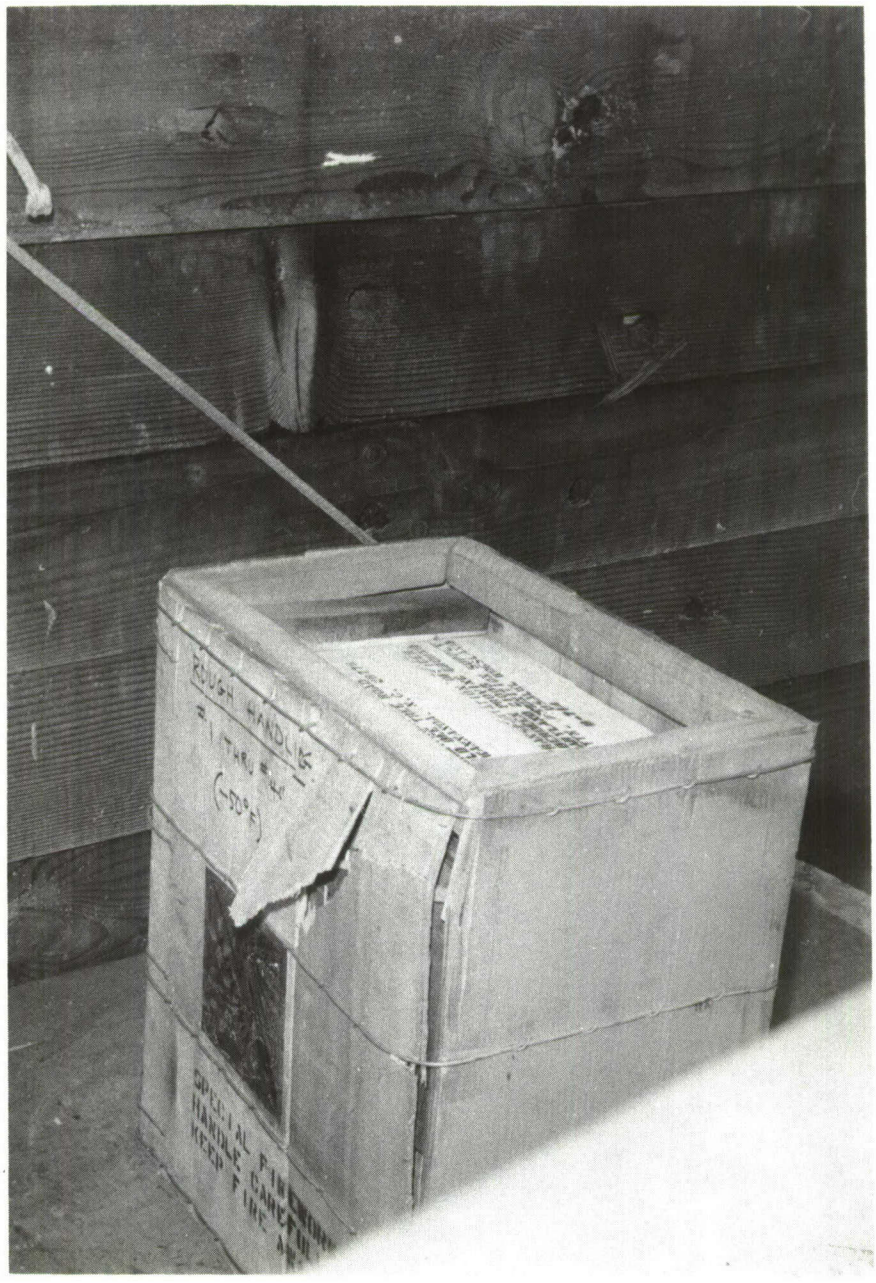
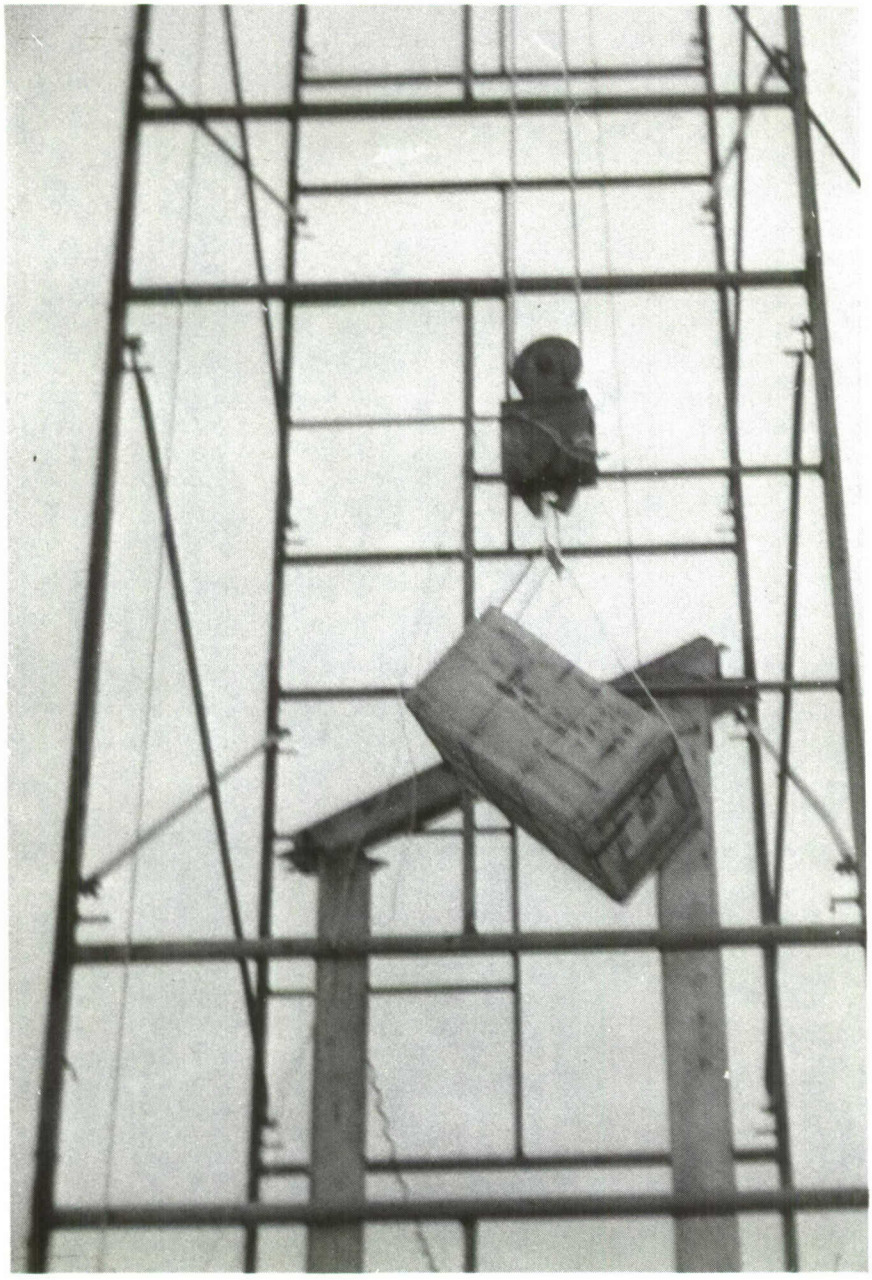


SEVEN FOOT PACKAGED DROP

G



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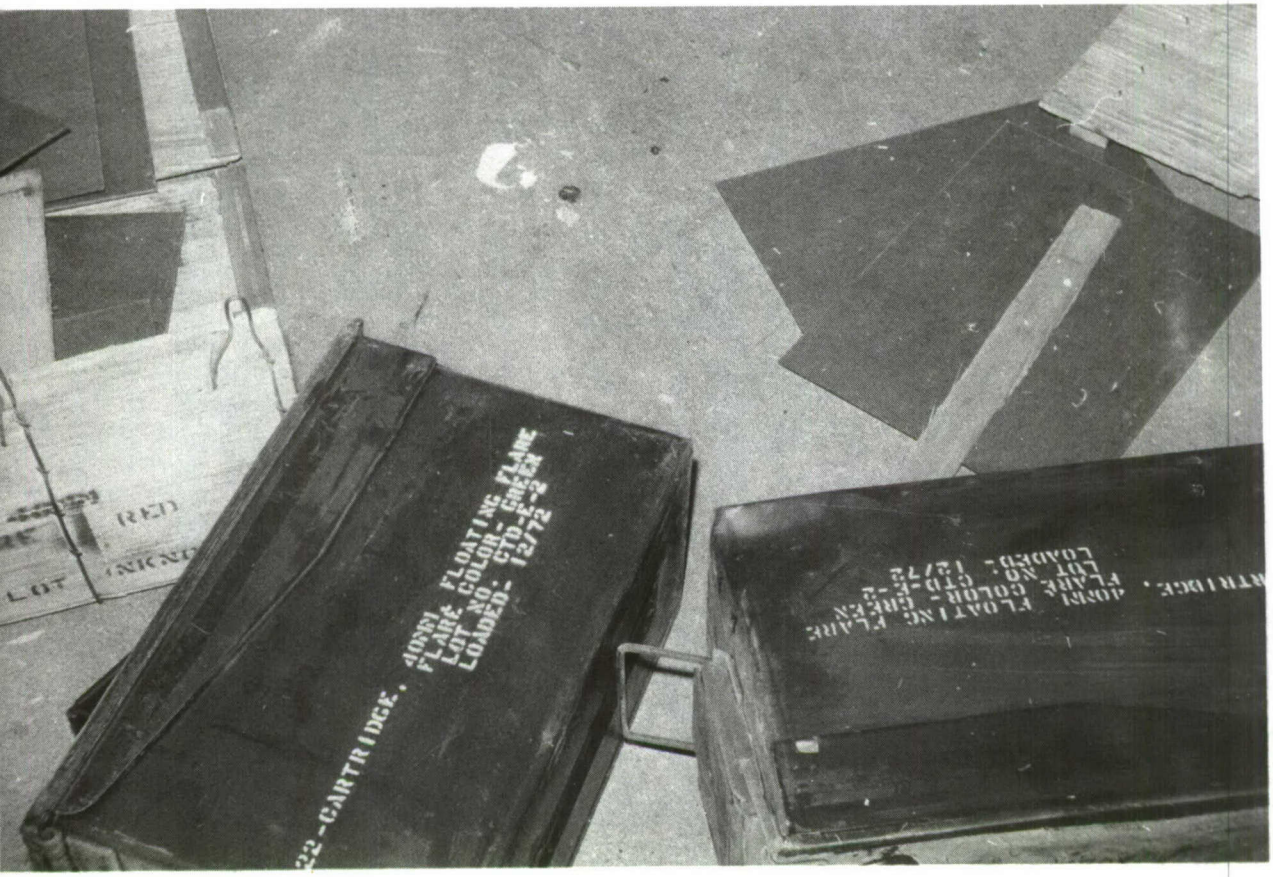
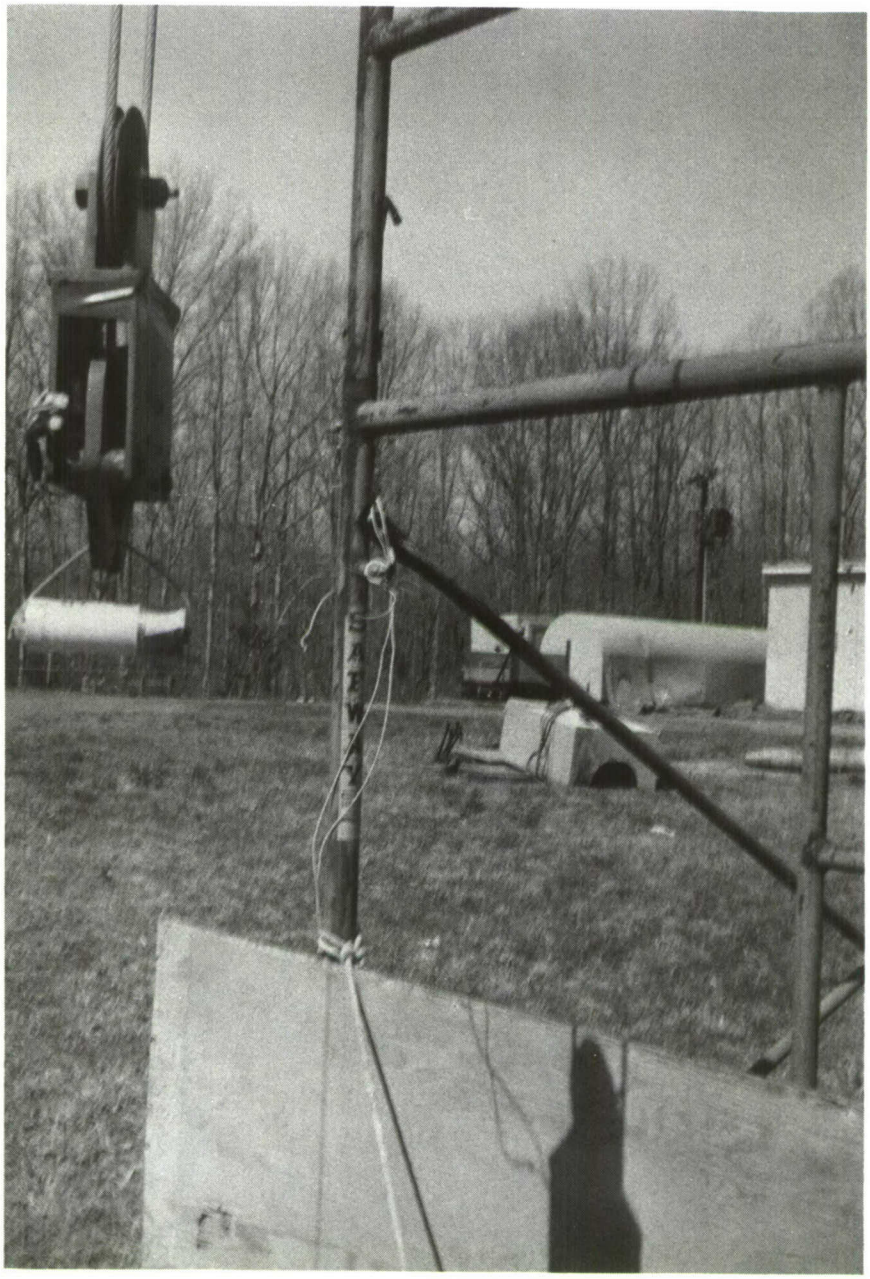


SEVEN FOOT PACKAGED DROP

G

LOOSE CARGO (BOUNCE)

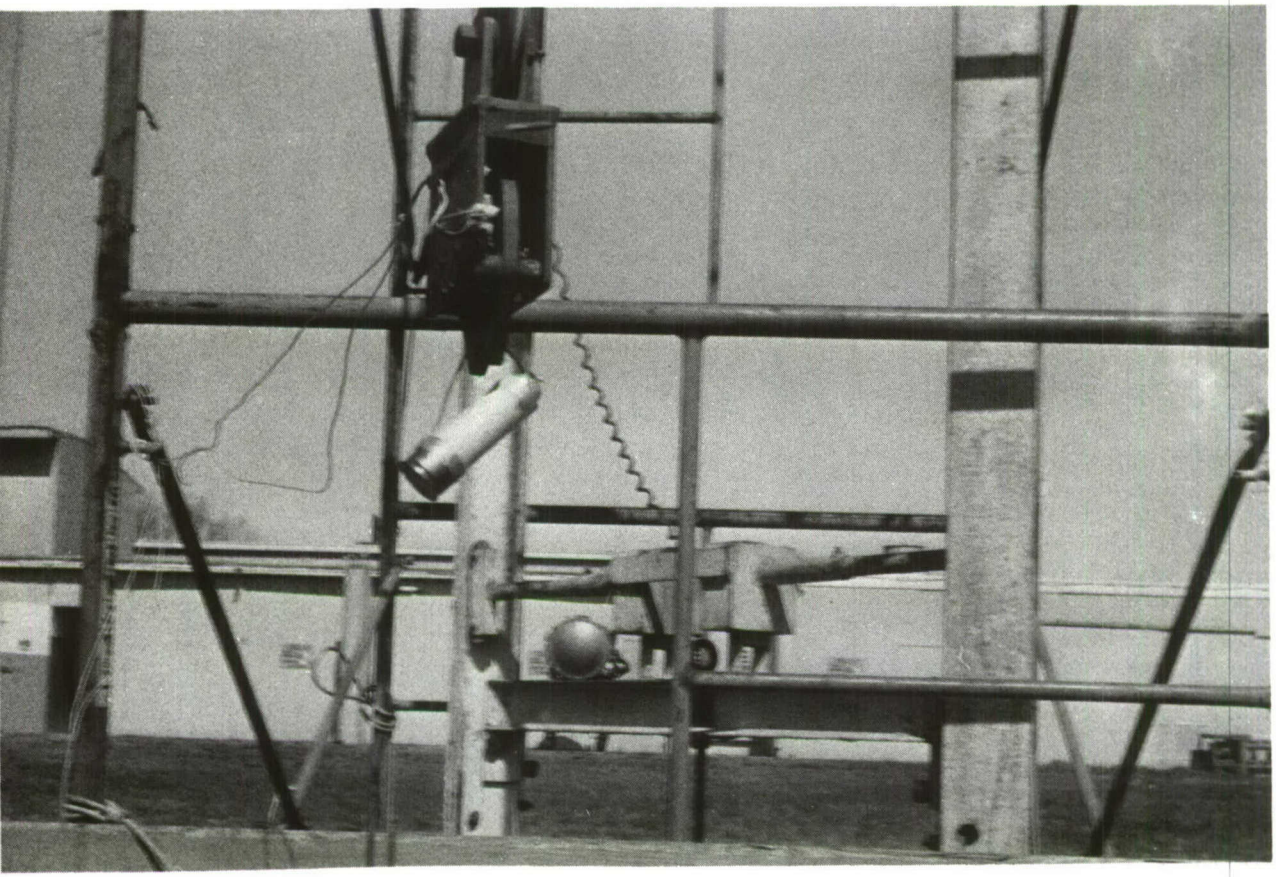
G



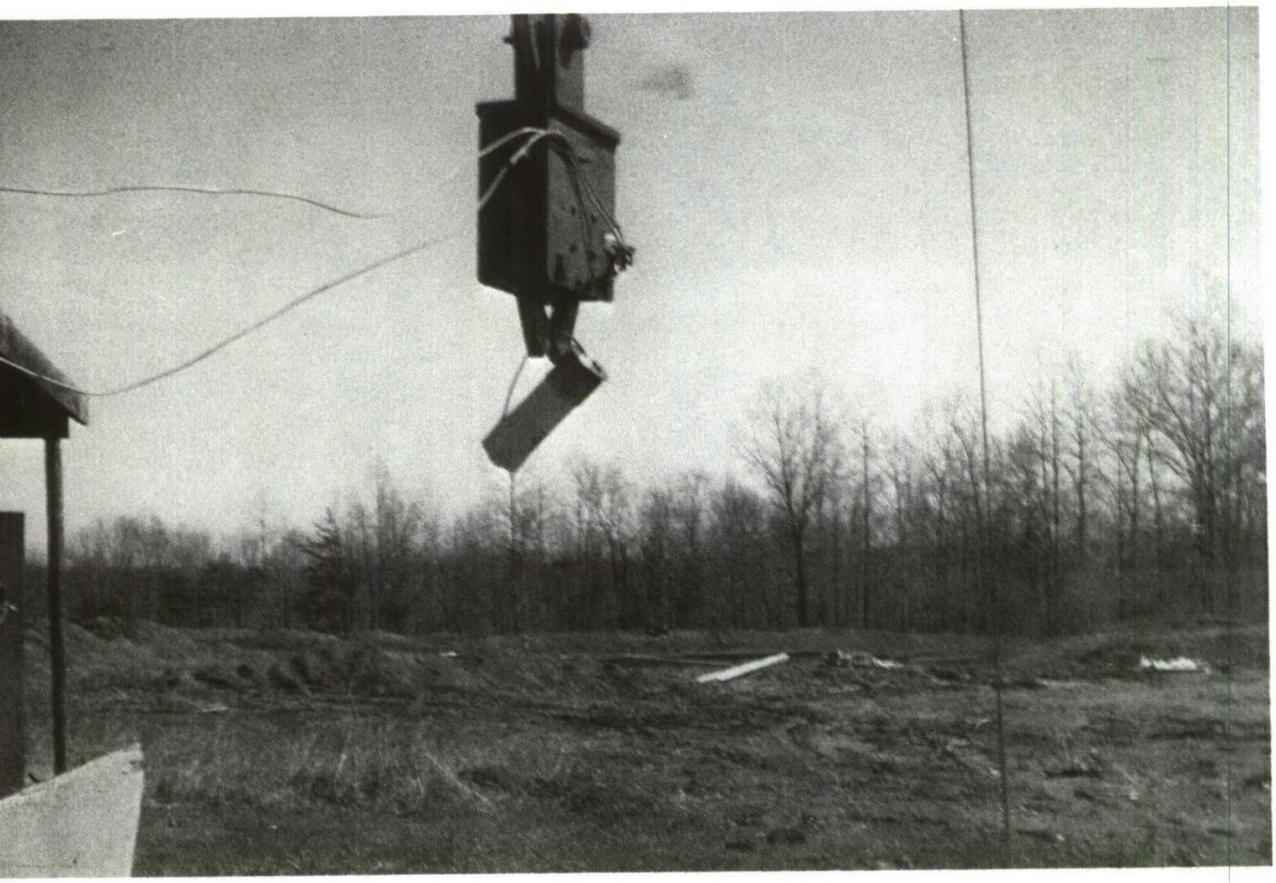
FIVE FOOT DROP
(Horizontal)

FIVE FOOT DROP
(Base Down)

FIVE FOOT DROP
(Nose Down)

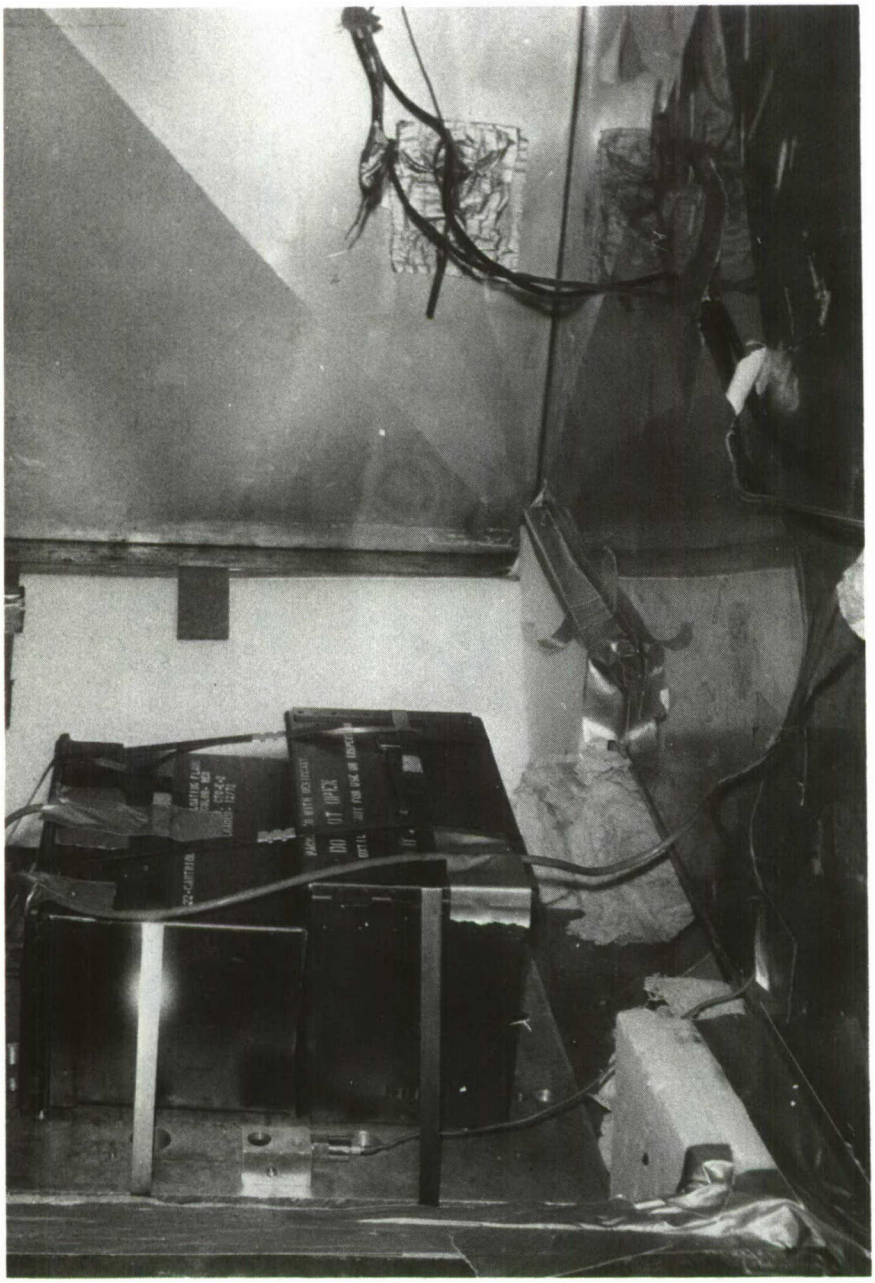


FIVE FOOT DROP
(45° Base Down)



FIVE FOOT DROP
(45° Nose Down)

HIGH HUMIDITY (STEADY STATE)



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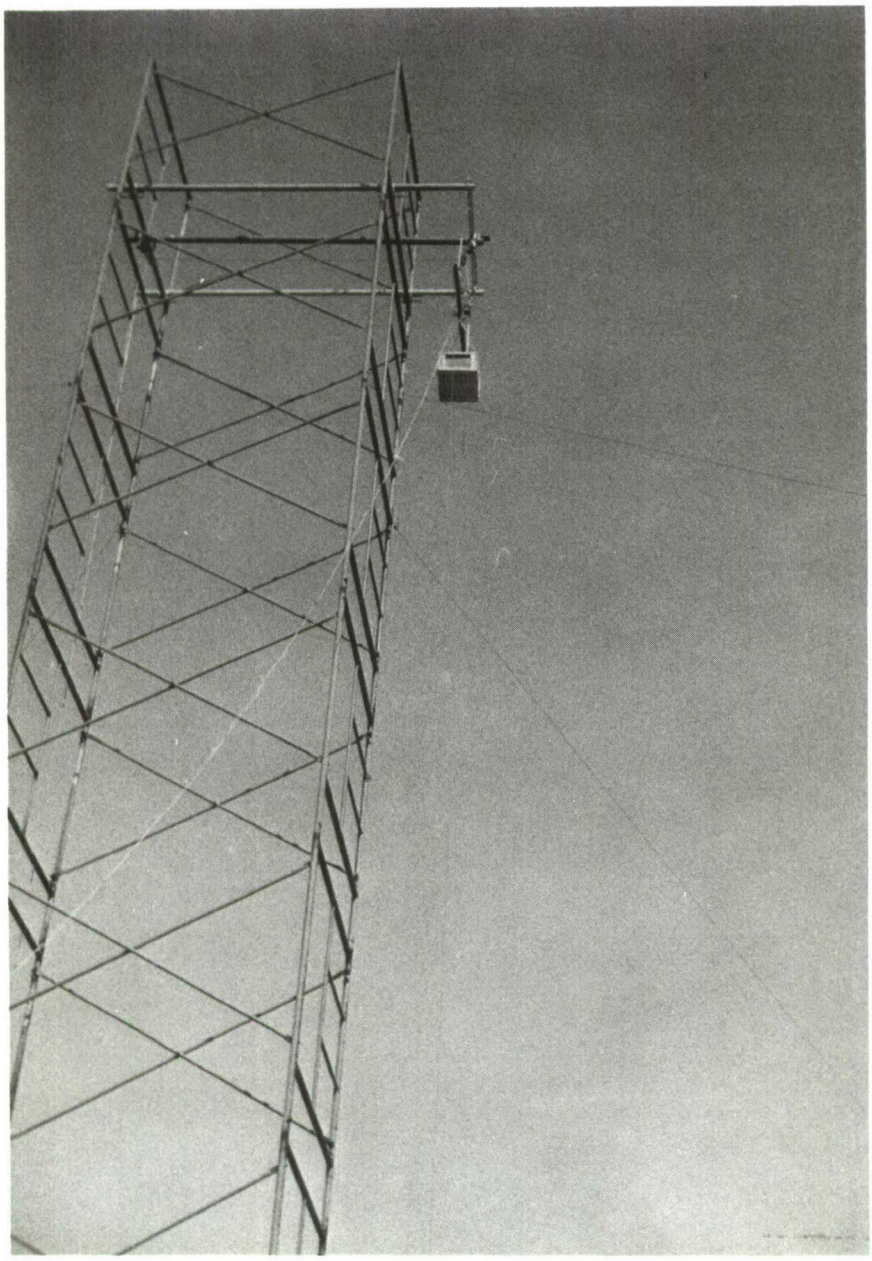
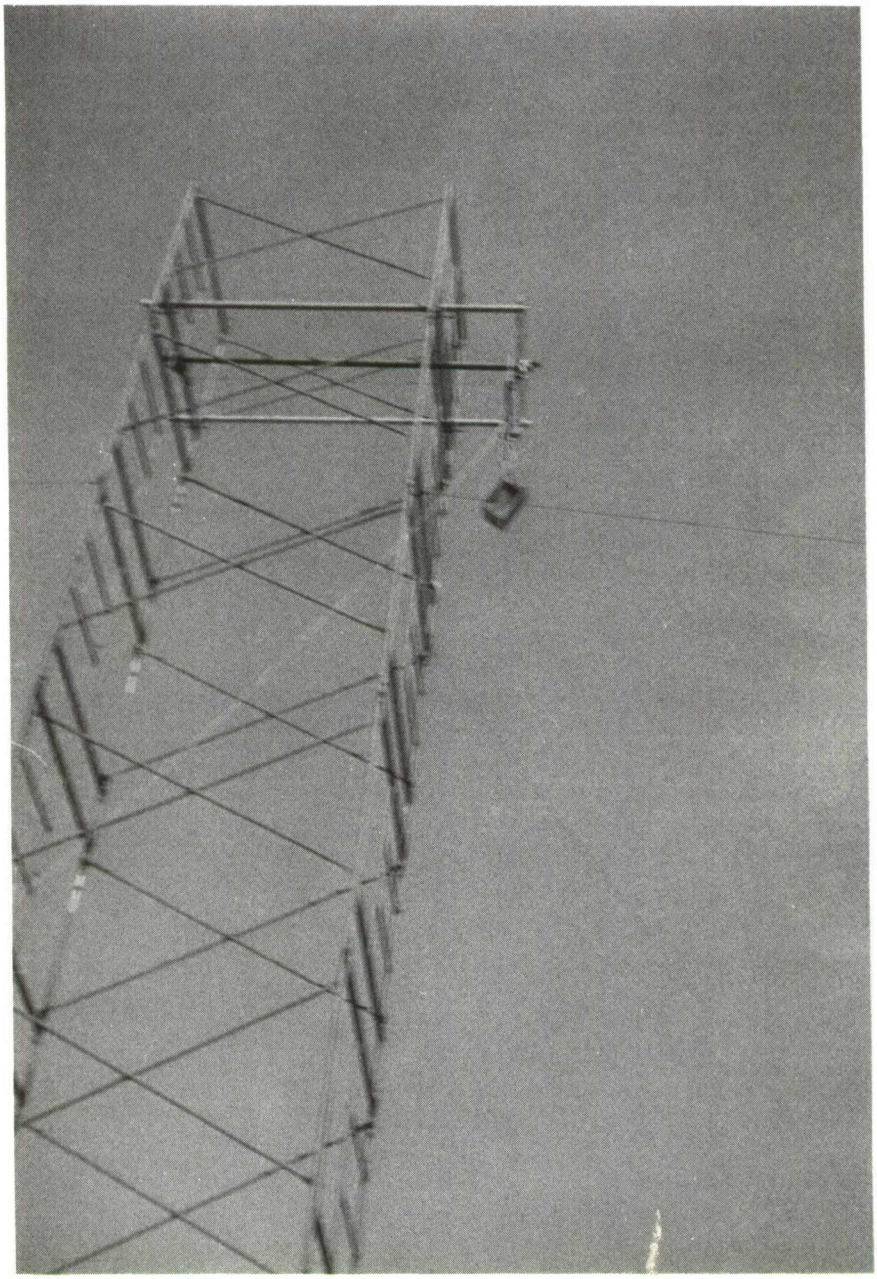


FORTY FOOT DROP

FORTY FOOT DROP



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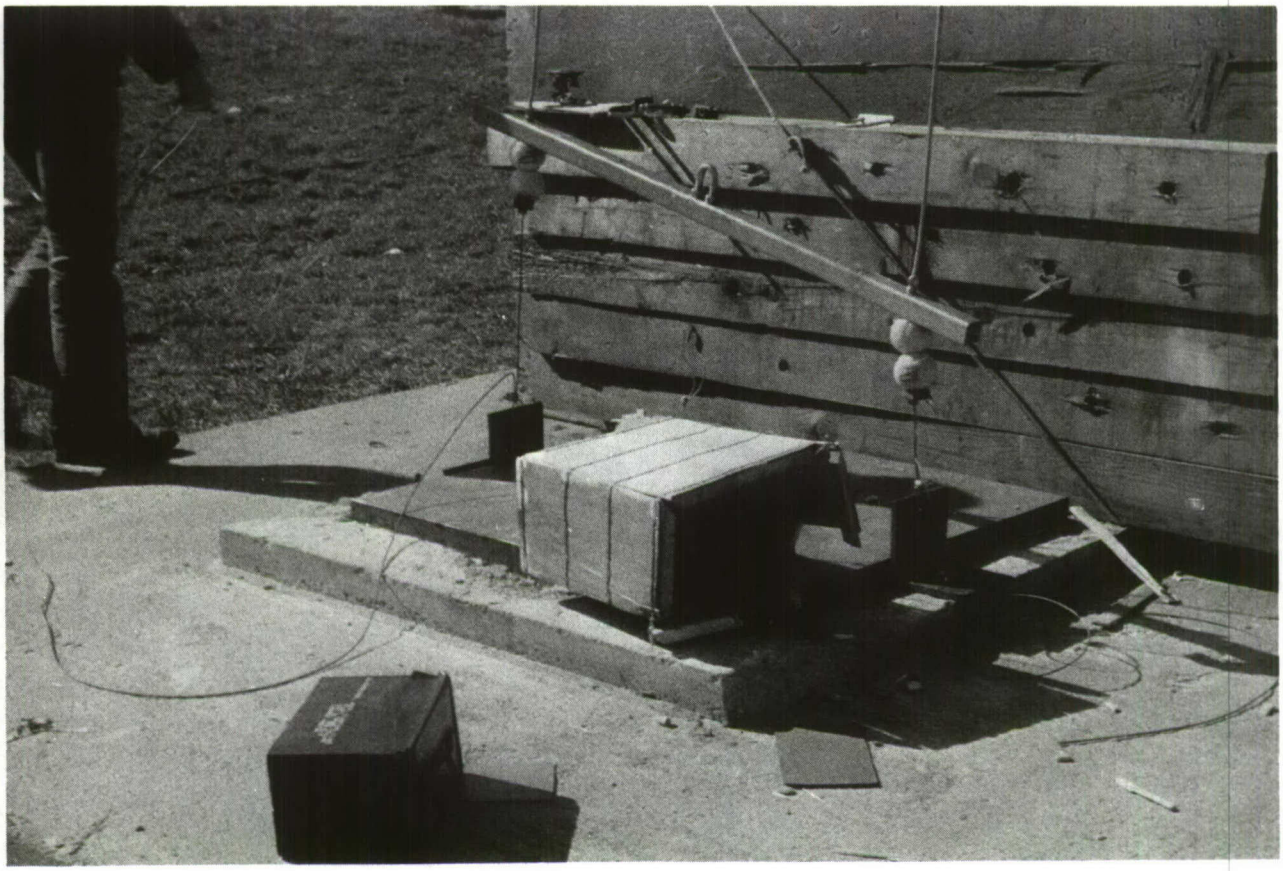
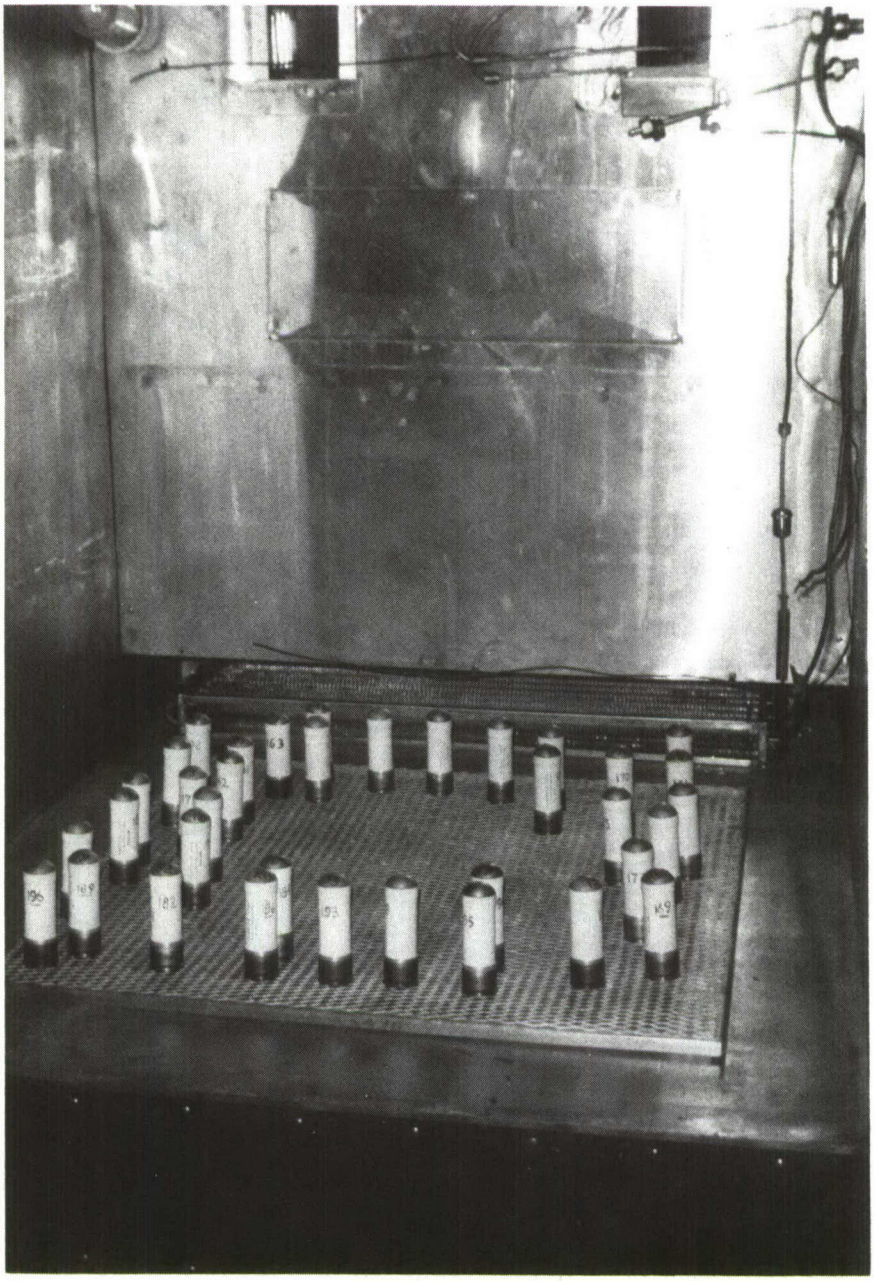


FORTY FOOT DROP



HIGH TEMPERATURE STORAGE

APPENDIX B

RECOIL TESTS

P.O. BOX 6767, BALTIMORE, MD. 212

A SUBSIDIARY OF UNITED INDUSTRIAL CORPORATION

IN REPLY PLEASE REFER TO:
191-3045/CW-3421

JUN 25 1973

Department of the Army
U. S. Army Land Warfare Laboratory
Aberdeen Proving Ground, Maryland 21005

Attention: RDLW-DEF

Subject: Work Assignment Technical Report

Reference: Contract No. DAAD05-73-C-0214 (Item 0002, Seq. No. A003)
Work Assignment 10:40MM Floating Flare

This is a final technical report for the referenced contract work assignment.

The objective of this work assignment was to conduct ballistic pendulum tests on the 40MM Floating Flare cartridges remaining from performance tests conducted on Work Assignment 2 of the referenced contract.

The test rounds had been previously conditioned during the performance testing phase (refer to LWL Technical Memorandum No. LWL-CR-02F71B), withdrawn, and saved for subsequent recoil tests.

A later test requirement specified additional temperature conditioning prior to recoil testing and firing while the cartridges were at temperature. In all, 63 cartridges were test fired for recoil: 21 green, 21 red, and 21 yellow. In most cases, each cartridge was conditioned at the temperature it had been subjected to previously.

To measure recoil, the M79 launcher was mounted on a ballistic pendulum suspended by vertical wires. At firing, as the pendulum recoiled rearward, the vertical movement from rest to the rearwardmost position was noted and recorded for each cartridge. From this, and using the weight of the recoiling mass, the energy and recoil impulse were calculated.

All testing was performed at H.P. White, Bel Air, Maryland, with AAI supervision on 18 June 1973.

TELEPHONE: 301-666-1400

JUN 25 1973

The general operation of all cartridges were normal at launch. The operation of the flare projectile was not evaluated during these tests. The average recoil impulse values which resulted are as follows:

Overall average	-	3.33 lb-sec
Average at -50°F	-	3.28
Average at ambient	-	3.33
Average at 145°F	-	3.39

Enclosed is a tabulation of the test results listing environmental conditioning for each round and the calculated values for recoil energy and recoil impulse.

Yours very truly,

AAI Corporation

T. R. Lawson
Contract Administrator

MGP/alt

Enclosures: Recoil Test Data

cc: 2 copies of letter and enclosure

RECOIL TEST DATA

NO.	COLOR	PREVIOUS CONDITIONING	CONDITIONING FOR RECOIL TESTS	TEST RESULTS	
				RECOIL ENERGY (FT-LBS)	RECOIL IMPULSE (LB-SEC)
4	Green	(-50°F) 7-Foot Drop	-50°F	17.77	3.02
5	Red		-50°	19.84	3.14
6	Yellow		Ambient	13.63	2.65
10	Green	Loose Cargo Axis Paral.	-50°	19.84	3.19
11	Red		-50°	17.08	2.96
12	Yellow		Ambient	22.60	3.41
20	Red	5-Foot Drop, Nose	-50°	18.46	3.08
21	Yellow	45° Base	-50°	17.08	2.96
22	Green	Axis Paral. 5-Foot Drop, 45° Nose	Ambient	21.91	3.36
26	Red		-50°	19.84	3.19
27	Yellow		-50°	21.22	3.30
28	Green		Ambient	22.60	3.41
32	Red	Axis Perpen.	-50°	22.60	3.41
33	Yellow		-50°	21.91	3.36
34	Green		Ambient	21.91	3.36
42	Yellow	5-Foot Drop, Nose	-50°	19.15	3.14
43	Green	, Base	-50°	19.84	3.19
44	Red	(-50°F) 7-Foot Drop Axis Perpen. 5-Foot Drop, Horiz.	Ambient	23.98	3.51

RECOIL TEST DATA

NO.	COLOR	PREVIOUS CONDITIONING	CONDITIONING FOR RECOIL TESTS	TEST RESULTS	
				RECOIL ENERGY (FT-LBS)	RECOIL IMPULSE (LB-SEC)
48	Yellow	(145°F) → 7-Foot Drop → (145°F)	145°F	19.15	3.14
49	Green	7-Foot Drop → 7-Foot Drop	145°	21.22	3.30
50	Red		Ambient	Missed	Reading
54	Yellow	Loose Cargo Axis Paral.	145°	21.91	3.36
55	Green		145°	24.67	3.56
56	Red		Ambient	20.53	3.25
64	Green	5-Foot Drop, Nose	145°	23.29	3.46
65	Red	, 45° Base	145°	23.29	3.46
66	Yellow	Axis Paral. → Axis Paral.	Ambient	18.46	3.08
70	Green	5-Foot Drop, 45° Nose	145°	21.91	3.36
71	Red		145°	19.84	3.19
72	Yellow		Ambient	19.84	3.19
76	Green	Axis Perpen.	145°	23.98	3.51
77	Red		145°	26.05	3.66
78	Yellow		Ambient	22.60	3.41
86	Red	5-Foot Drop, Nose	145°	23.98	3.51
87	Yellow	, Base	145°	22.60	3.41
88	Green	7-Foot Drop → Axis Perpen. → 5-Foot Drop, Horiz.	Ambient	23.98	3.51

RECOIL TEST DATA

NO.	COLOR	PREVIOUS CONDITIONING	CONDITIONING FOR RECOIL TESTS	TEST RESULTS	
				RECOIL ENERGY (FT-LBS)	RECOIL IMPULSE (LB-SEC)
104	Green	High Humidity	Ambient	20.53	3.25
105	Red	↓	↓	22.60	3.41
106	Yellow	High Humidity	Ambient	21.22	3.30
122	Green	Vibration (-50°F) Axis Paral.	-50°F	26.05	3.66
123	Red	↓ ↓	↓	26.74	3.71
124	Yellow	Axis Paral.	↓	21.22	3.30
128	Green	Axis Perpen.	↓	21.91	3.36
129	Red	↓	-50°F	24.67	3.56
130	Yellow	(-50°F) Axis Perpen.	Ambient	22.60	3.41
134	Green	(145°F) Axis Paral.	145°F	21.91	3.36
135	Red	↓ ↓	↓	20.53	3.25
136	Yellow	Axis Paral.	↓	22.60	3.41
140	Green	Axis Perpen.	↓	22.60	3.41
141	Red	↓	145°F	23.29	3.46
142	Yellow	Vibration (145°F) Axis Perpen.	Ambient	24.67	3.56

RECOIL TEST DATA

NO.	COLOR	PREVIOUS CONDITIONING	CONDITIONING FOR RECOIL TESTS	TEST RESULTS	
				RECOIL ENERGY (FT-LBS)	RECOIL IMPULSE (LB-SEC)
173	Green	High Temperature Storage (125°F)	145°F	21.91	3.36
174	Red		145°	19.84	3.19
175	Yellow		Ambient	21.22	3.30
176	Green		Ambient	23.29	3.46
177	Red		-50°	18.46	3.08
178	Yellow	(125°F)	-50°	23.98	3.51
191	Green	(160°F)	145°	21.22	3.30
192	Red		145°	23.29	3.46
193	Yellow		Ambient	21.91	3.36
194	Green		Ambient	22.60	3.41
195	Red		-50°	25.36	3.61
196	Yellow	High Temperature Storage (160°F)	-50°	19.15	3.14